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U. S. DEPARTMENT OF AGRICULTURE
WEATHER BUREAU
CHARLES F. MARVIN, Chief

MONTHLY WEATHER REVIEW

VOLUME 46, No. 9

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Fig. 4. Departures from Normal Temperature, 7 p. m., 75th meridian time, August 8, 1918.

SEPTEMBER, 1918.

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NOTICE TO CONTRIBUTORS.

Contributions intended for publication in any given issue of the MONTHLY WEATHER REVIEW (e. g., January) should be in the hands of the editor before the end of the next following month (e. g., February), if no illustrations are required. When the paper is illustrated, the manuscript and the copy for illustrations must be submitted much earlier, in order to permit copy being prepared for the engraver by the end of the month.

REPRINTS are made up without covers in the original size and pagination of the REVIEW. They will not be furnished unless specifically REQUESTED WHEN THE MANUSCRIPT IS SUBMITTED.

MONTHLY WEATHER REVIEW

HERBERT H. KIMBALL, Acting Editor.

VOL. 46, No. 9. W. B. No. 664. SEPTEMBER, 1918. CLOSED NOV. 2, 1918. ISSUED DEC. 7, 1918.

INTRODUCTION.

As explained in this Introduction during 1914, the MONTHLY WEATHER REVIEW now takes the place of the Bulletin of the Mount Weather Observatory and of the voluminous publication of the climatological service of the Weather Bureau. The MONTHLY WEATHER REVIEW contains contributions from the research staff of the Weather Bureau and also special contributions of a general character in any branch of meteorology and climatology.

SUPPLEMENTS to the MONTHLY WEATHER REVIEW are published from time to time.

The climatological service of the Weather Bureau is maintained in all its essential features, but its publications, so far as they relate to purely local conditions, are incorporated in the monthly reports "Climatological Data" for the respective States, Territories, and colonies.

Since August, 1915, the material for the MONTHLY WEATHER REVIEW has been prepared and classified in accordance with the following sections:

SECTION 1.—*Aerology.*—Data and discussions relative to the free atmosphere.

SECTION 2.—*General meteorology.*—Special contributions by any competent student bearing on any branch of meteorology and climatology, theoretical or otherwise.

SECTION 3.—*Forecasts and general conditions of the atmosphere.*

SECTION 4.—*Rivers and floods.*

SECTION 5.—*Seismology.*—Results of observations by Weather Bureau observers and others as reported to the Washington office.

SECTION 6.—*Bibliography.*—Recent additions to the Weather Bureau library; recent papers bearing on meteorology.

SECTION 7.—*Weather of the month.*—Summary of local weather conditions; climatological data from regular Weather Bureau stations; tables of accumulated and excessive precipitation; data furnished by the Canadian Meteorological Service; monthly charts Nos. 1, 2, 3, 4, 5, 6, 7, 8, the same as hitherto; Meterological Summary and chart No. 9 of the North Atlantic Ocean for this month in 1917. Owing to the fact that ocean meteorological data are frequently not available for a considerable time after the close of the month to which they relate, the chart and text matter in connection therewith appear one year late.

In general, appropriate officials prepare the seven sections above enumerated; but *all students of atmospherics are cordially invited to contribute such additional articles as seem to be of value.*

The voluminous tables of data and text relative to local climatological conditions, that during recent years were prepared by the 12 respective "district editors," are omitted from the MONTHLY WEATHER REVIEW, but are collected and published by States at selected section centers. (See cover, p. 3.)

The data needed in Section 7 can only be collected and prepared several weeks after the close of the month designated on the title-page; hence the REVIEW as a whole can only issue from the press within about eight weeks from the end of that month.

It is hoped that the meteorological data hitherto contributed by numerous independent services will continue as in the past. Our thanks are specially due to the directors and superintendents of the following:

The Meteorological Service of the Dominion of Canada.
The Meteorological Service of Cuba.
The Meteorological Observatory of Belen College, Habana.
The Government Meteorological Office of Jamaica.
The Meteorological Service of the Azores.
The Meteorological Office, London.
The Danish Meteorological Institute.
The Physical Central Observatory, Petrograd.
The Philippine Weather Bureau.

The Weather Bureau desires that the MONTHLY WEATHER REVIEW shall be a medium of publication for contributions within its field, but such publications is not to be construed as official approval of the views expressed.

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SECTION I.—AEROLOGY.

SOLAR AND SKY RADIATION MEASUREMENTS DURING SEPEMBER, 1918.

By HERBERT H. KIMBALL, Professor of Meteorology.

[Dated: Weather Bureau, Washington, D. C., Oct. 31, 1918.]

For a description of instrumental exposures, and an account of the methods of obtaining and reducing the measurements, the reader is referred to the REVIEW for January, 1918, **46**:2.

The monthly means and departures from normal values given in Table 1 show that direct solar radiation averaged above normal at Madison, Wis., and Lincoln, Nebr., and below normal at Washington, D. C., and Santa Fe., N. Mex. The minus departures at the latter station may be due in part to the fact that owing to an injury to the galvanometer no observations were obtained after the 12th of the month, and radiation intensities usually increase rapidly with the season at this time of the year.

Table 3 shows an excess of about 5 per cent in the total radiation for the month at Lincoln, and a deficiency of about 10 per cent at Washington.

Skylight polarization measurements obtained on 7 days at Washington give a mean of 57 per cent with a maximum of 62 per cent on the 21st. These values are considerably below the September averages. At Madison measurements obtained on 8 days give a mean of 67 per cent, with a maximum of 74 per cent on the 26th.

TABLE 1.—*Solar radiation intensities during September, 1918.*

[Gram-calories per minute per square centimeter of normal surface.]

Washington, D. C.

Date.	Sun's zenith distance.									
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Sept. 7	1.35	1.24	.....	.....	.....	.....	.....	.....	.....	.....
9	1.26	1.14	1.02	0.94	0.87	0.78	.....	.....	.....	.....
10	1.08	1.02	.....	0.75	0.68	0.62	0.58	0.54	0.51	0.48
13	1.30	1.23	1.10	0.87	0.69	0.56	.....	.....	.....	.....
19	.....	1.17	1.10	1.03	0.97	0.90	0.84	.....	.....	.....
21	.....	1.17	1.09	1.01	0.93	.....	.....	.....	.....	.....
23	.....	1.05	0.91	0.79	0.68	0.60	0.54	.....	.....	.....
27	.....	1.27	1.19	1.11	1.03	.....	.....	.....	.....	.....
30	.....	1.15	1.07	0.96	0.87	.....	.....	.....	.....	.....
Monthly means	**1.25**	**1.16**	**1.07**	**0.93**	**0.84**	**0.69**	**0.65**	**(0.54)**	**(0.51)**	**(0.48)**
Departure from 10-year normal	**−0.07**	**−0.04**	**−0.01**	**−0.06**	**−0.05**	**−0.10**	**−0.06**	**−0.11**	**−0.14**	**−0.14**
P. M.										
Sept. 19	.....	.....	1.09	0.97	0.88	0.80	.....	.....	.....	.....
23	.....	1.19	1.09	0.99	0.90	0.82	0.76	.....	.....	.....
30	.....	1.13	0.93	0.76	0.65	0.58	0.51	0.46	0.39	.....
Monthly means	.....	**(1.16)**	**1.04**	**0.91**	**0.81**	**0.73**	**(0.64)**	**(0.46)**	**(0.39)**	.....
Departure from 10-year normal	.....	**−0.04**	**−0.02**	**−0.05**	**−0.06**	**−0.06**	**−0.10**	**−0.26**	**−0.29**	.....

TABLE 1.—*Solar radiation intensities during September, 1918*—Contd.

[Gram-calories per minute per square centimeter of normal surface.]

Madison, Wis.

Date.	Sun's zenith distance.									
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Sept. 21	.....	1.39	1.27	.....	.....	.....	.....	.....	.....	.....
23	.....	1.15	1.01	0.89	0.81	0.73	0.63	.....	.....	.....
26	.....	1.44	1.35	1.26	1.18	1.13	1.10	1.07	.....	.....
27	.....	1.32	1.25	1.16	1.08	.....	.....	0.92	0.88	.....
28	.....	1.25	1.13	1.02	0.92	0.78	0.71	0.65	.....	.....
Monthly means	.....	**1.31**	**1.20**	**1.08**	**1.00**	**0.85**	**0.81**	**0.88**	**(0.88)**	.....
Departure from 9-year normal	.....	**+0.06**	**+0.05**	**+0.03**	**+0.02**	**−0.04**	**−0.04**	**+0.03**	.....	.....
P. M.										
Sept. 16	.....	1.40	1.30	1.22	.....	.....	.....	.....	.....	.....
21	.....	1.35	1.23	.....	.....	.....	.....	.....	.....	.....
23	.....	1.13	.....	.....	.....	.....	.....	.....	.....	.....
26	.....	1.42	1.33	1.24	1.16	1.08	1.00	.....	.....	.....
28	.....	1.28	1.20	1.14	1.09	1.04	0.98	.....	.....	.....
30	.....	1.41	1.29	1.22	.....	.....	.....	.....	.....	.....
Monthly means	.....	**1.33**	**1.27**	**1.20**	**(1.12)**	**(1.06)**	**(0.99)**	.....	.....	.....
Departure from 9-year normal	.....	**+0.08**	**+0.12**	**+0.15**	**+0.10**	**0.25**	**+0.14**	.....	.....	.....

Lincoln, Nebr.

A. M.										
Sept. 4	.....	.....	1.15	1.07	1.00	0.93	.....	.....	.....	.....
6	.....	1.35	1.29	1.23	1.17	1.07	0.98	.....	.....	.....
7	.....	1.22	1.19	1.11	1.05	0.96	0.89	.....	.....	0.83
11	.....	1.30	1.18	1.06	0.95	0.87	0.80	0.73	0.68	.....
12	.....	1.35	1.22	1.12	1.04	0.97	.....	.....	.....	.....
16	.....	1.42	1.31	1.22	1.14	1.05	0.98	.....	.....	.....
17	.....	1.32	1.26	1.21	.....	.....	.....	.....	.....	.....
18	.....	1.30	1.23	1.10	1.01	0.92	.....	.....	.....	.....
20	.....	1.45	1.35	1.26	1.18	1.10	1.03	0.92	.....	.....
21	.....	1.36	1.30	1.25	1.14	1.08	1.03	0.95	0.90	.....
23	.....	1.28	1.20	1.12	1.04	0.97	0.90	0.84	.....	.....
26	.....	1.40	1.25	1.12	1.05	0.98	0.92	0.87	0.81	.....
27	.....	1.29	1.09	1.04	0.82	0.76	0.70	.....	.....	.....
28	.....	1.28	1.19	1.06	0.94	0.84	0.75	.....	.....	.....
Monthly means	.....	**1.33**	**1.23**	**1.14**	**1.04**	**0.96**	**0.90**	**0.86**	**0.80**	**(0.83)**
Departure from 4-year normal	.....	**+0.04**	**+0.05**	**+0.07**	**+0.05**	**+0.06**	**+0.07**	**+0.09**	**+0.03**	.....
P. M.										
Sept. 4	.....	1.22	1.09	0.98	.....	.....	.....	.....	.....	.....
7	.....	1.27	1.04	0.95	0.92	.....	.....	0.74	0.69	0.65
11	.....	1.33	1.24	1.14	1.06	0.98	0.91	0.86	0.81	.....
12	.....	.....	.....	.....	.....	1.02	0.95	0.89	0.83	0.79
13	.....	1.24	1.14	1.05	0.97	0.90	0.83	0.76	0.70	0.65
20	.....	1.41	1.29	1.18	1.11	1.04	0.97	0.86	0.77	.....
21	.....	1.34	1.20	1.10	1.02	0.94	0.87	0.80	0.74	0.69
26	.....	1.33	1.23	1.17	1.12	1.02	0.96	0.90	0.85	0.80
28	.....	1.32	1.20	1.11	1.02	0.93	0.86	0.80	0.75	0.69
Monthly means	.....	**1.31**	**1.18**	**1.08**	**1.03**	**0.98**	**0.91**	**0.83**	**0.77**	**0.71**
Departure from 4-year normal	.....	**+0.03**	**+0.04**	**+0.02**	**+0.07**	**+0.08**	**+0.08**	**+0.04**	**+0.03**	**+0.01**

TABLE 1.—*Solar radiation intensities during September, 1918*—Contd.

[Gram-calories per minute per square centimeter of normal surface.]

Santa Fe, N. Mex.

Date.	Sun's zenith distance.									
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
Sept. 7	1.48	1.33	1.29	1.26	1.12	.....	.....	0.98	0.94	.....
9	.....	1.29	.....	.....	.....	.....	.....	.....	.....	.....
12	1.42	1.37	1.24	1.16	1.08	1.01	.....	.....	.....	.....
Monthly means	(1.45)	1.33	(1.26)	(1.21)	(1.10)	1.01)	.....	(0.98)	(0.94)	.....
Departure from 2-year normal	−0.06	−0.07	−0.05	−0.03	−0.06	−0.10	.....	−0.02	−0.02	.....
P. M.										
Sept. 6	.....	.....	1.28	1.20	.....	.....	.....	.....	0.90	0.84
10	.....	1.32	1.26	.....	.....	.....	.....	.....	.....	.....
Monthly means	.....	(1.32)	(1.27)	(1.20)	.....	.....	.....	.....	(0.90)	(0.84)
Departure from 2-year normal	.....	−0.14	−0.11	−0.09	.....	.....	.....	.....	−0.03	−0.05

TABLE 2.—*Vapor pressures at pyrheliometric stations on days when solar radiation intensities were measured.*

Washington, D. C.			Madison, Wis.			Lincoln, Nebr.			Santa Fe, N. Mex.		
Date.	8 a.m.	8 p.m.	Date.	8 a.m.	8 p.m.	Date.	8 a.m.	8 p.m.	Date.	8 a.m.	8 p.m.
1918.	mm.	mm.	1918.	mm.	mm.	1918.	mm.	mm.	1918.	mm.	mm.
Sept. 7	8.81	10.59	Sept. 16	6.76	6.02	Sept. 5	6.76	6.76	Sept. 6	7.29	6.76
9	9.14	11.38	21	5.16	6.02	6	6.50	6.50	7	6.76	7.29
10	10.21	12.24	23	7.29	10.21	7	8.18	7.57	9	7.29	9.83
13	10.97	10.59	26	5.16	5.16	11	10.21	7.87	10	8.48	10.59
19	12.68	14.10	27	4.75	6.02	12	6.76	4.75	12	8.81	5.56
21	7.04	5.56	28	5.79	6.76	13	7.29	7.29	.....	.....	.....
23	7.29	8.48	30	5.79	4.75	16	6.27	4.17	.....	.....	.....
27	5.56	8.18	.....	.....	.....	17	5.36	10.21	.....	.....	.....
30	7.29	11.38	.....	.....	.....	18	4.95	6.02	.....	.....	.....
.....	.....	.....	.....	.....	.....	20	3.99	3.00	.....	.....	.....
.....	.....	.....	.....	.....	.....	21	3.81	4.57	.....	.....	.....
.....	.....	.....	.....	.....	.....	23	7.29	7.29	.....	.....	.....
.....	.....	.....	.....	.....	.....	26	7.29	9.83	.....	.....	.....
.....	.....	.....	.....	.....	.....	27	4.17	4.57	.....	.....	.....
.....	.....	.....	.....	.....	.....	28	5.16	7.87	.....	.....	.....

TABLE 3.—*Daily totals and departures of solar and sky radiation during September, 1918.*

[Gram-calories per square centimeter of normal surface.]

Day of month.	Daily totals.			Departures from normal.			Excess or deficiency since first of month.		
	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.
	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
Sept. 1	548	492	288	141	99	−157	141	99	−15
2	465	195	319	60	−196	−124	201	−97	−28
3	378	230	51	−26	−158	−391	175	−255	−67
4	382	178	565	−20	−207	124	155	−462	−54
5	329	539	545	−72	157	105	83	−305	−44
6	152	493	576	−247	115	138	−164	−190	−30
7	456	281	583	59	−94	148	−105	−284	−15
8	127	450	548	−269	79	116	−374	−205	−4
9	451	202	173	57	−165	−257	−317	−370	−29
10	455	267	188	63	−96	−239	−254	−466	−53

TABLE 3.—*Daily totals and departures of solar and sky radiation during September, 1918*—Continued.

[Gram-calories per square centimeter of normal surface.]

Day of month.	Daily totals.			Departures from normal.			Excess or deficiency since first of month.		
	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.
	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
Sept. 11	235	143	573	−156	−216	149	−410	−682	−388
12	209	151	584	−120	−204	163	−530	−886	−225
13	486	432	453	99	81	35	−431	−805	−190
14	446	298	469	60	−139	54	−371	−944	−136
15	416	456	136	32	113	−276	−339	−831	−412
16	204	415	541	−178	75	132	−517	−756	−280
17	228	296	454	−151	−40	47	−668	−796	−233
18	145	357	520	−232	24	116	−900	−772	−117
19	446	419	529	72	90	127	−828	−682	10
20	35	200	581	−337	−126	182	−1,165	−808	192
Decade departure							−911	−342	729
21	272	476	573	−98	154	176	−1,263	−654	368
22	448	455	544	80	136	150	−1,183	−518	518
23	434	429	455	69	114	64	−1,114	−404	582
24	380	378	282	17	66	−107	−1,097	−338	475
25	401	278	357	40	−30	−29	−1,057	−368	446
26	189	459	544	−169	154	161	−1,226	−214	607
27	434	435	522	80	133	141	−1,146	−81	748
28	315	417	483	−36	119	105	−1,182	38	853
29	362	123	444	15	−172	68	−1,167	−134	921
30	424	392	66	80	100	−307	−1,087	−34	614
Decade departure							+78	+774	+422
Excess or deficiency since first of year.							−2,353	+904	+890
							(per cent) −2.2	+0.9	+0.8

WOLFER PROVISIONAL SUNSPOT RELATIVE NUMBERS.

By HERBERT H. KIMBALL, Professor of Meteorology.

The provisional relative sunspot numbers given in the table herewith are in continuation of the *observed relative* and the *smoothed relative* sunspot numbers published in the REVIEW for July, 1915, **43**:314.

While these provisional numbers are subject to slight revision, and later will be smoothed by the method described in the REVIEW for April, 1902, **30**:171, they are sufficiently accurate to show that at the crest of the maximum of 1917 the relative sunspot number was in excess of 100, which is unusually high.

The epoch of the last preceding maximum was 1906.4, so that the interval between the two has been very close to 11 years.

Wolfer provisional sunspot relative numbers, January, 1915–March, 1918.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
1915[1]	25.7	35.6	34.9	42.2	35.0	69.9	71.0	68.6	44.7	53.5	38.2	32.7	46.0
1916[2]	44.3	55.4	66.5	73.3	71.4	67.7	53.0	34.1	41.4	56.0	60.7	41.0	55.4
1917[2]	76.2	71.8	86.6	63.7	112.7	113.8	117.0	143.2	121.9	71.4	90.1	116.8	98.8
1918[2]	96.3	83.4	72.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[1] Met. Zeit, 1915, **32**: 188, 364, 508, and 1916, **33**: 42.
[2] Terr. Mag. Sept., 1918, **23**: 136.

HALO PHENOMENA OBSERVED DURING SEPTEMBER, 1918.

By WILLIS RAY GREGG, Meteorologist.

Station.	Altitude.	Latitude.	Longitude.	Date.	Form observed.	Time of—		Theodolite readings.					
						Beginning.	Ending.	Time.	Radius inside.	Radius outside.	Length of arc.	Distance from sun or moon.	Altitude of sun or moon.
	m.	° ′	° ′						°	°	°	°	°
*Broken Arrow, Okla.	233	36 02	95 49	11	Solar halo, 22°	9:35 a. m.	5:25 p. m.	1:46 p. m.	22.5	23	360	.....	52.5
				11	Lunar halo, 22°	7:15 p. m.	8:00 p. m.	.....	.....	.....	.....	.....	.....
				13	Solar halo, 22°	6:25 a. m.	7:45 a. m.	7:15 a. m.	22	22.5	.....	.....	14.5
				13	Parhelion, 22°, right.	6:25 a. m.	7:00 a. m.	.....	.....	.....	.....	.....	.....
				13	Parhelion, 22°, left.	6:25 a. m.	7:00 a. m.	.....	.....	.....	.....	.....	.....
				13	Upper tangent arc.	7:30 a. m.	7:40 a. m.	.....	.....	.....	.....	.....	.....
Canton, N. Y.	137	44 36	75 10	6	Solar halo, 22°	5:35 p. m.	5:55 p. m.	.....	.....	.....	.....	.....	.....
				7	Solar halo, 22°	7:50 a. m.	10:00 a. m.	.....	.....	.....	.....	.....	.....
				11	Solar halo, 22°	3:00 p. m.	.....	.....	.....	.....	.....	.....	.....
				18	Solar halo, 22°	7:50 a. m.	8:35 a. m.	.....	.....	.....	.....	.....	.....
				25	Solar halo, 22°	8:05 a. m.	9:00 a. m.	.....	.....	.....	.....	.....	.....
Cincinnati, Ohio.	191	39 06	84 30	2	Solar halo, 22°	10:30 a. m.	11:40 a. m.	.....	.....	.....	.....	.....	.....
				26	Solar halo, 22°	10:00 a. m.	4:40 p. m.	.....	.....	.....	.....	.....	.....
Dayton, Ohio.	274	39 46	84 10	2	Solar halo, 22°	6:00 a. m.	11:30 a. m.	.....	.....	.....	.....	.....	.....
				2	Solar halo, 46°	6:40 a. m.	7:10 a. m.	.....	.....	.....	.....	.....	.....
				25	Solar halo, 22°	11:45 a. m.	12:10 p. m.	.....	.....	.....	.....	.....	.....
				26	Solar halo, 22°	9:45 a. m.	11:40 a. m.	.....	.....	.....	.....	.....	.....
*Drexel, Nebr.	396	41 20	96 16	1	Solar halo, 22°	8:42 a. m.	1:12 p. m.	8:42 a. m.	22	23	360	.....	32
				17	Solar halo, 22°	10:45 a. m.	12:03 p. m.	11:00 a. m.	22	22.5	360	.....	47
				23	Solar halo, 22°	11:59 a. m.	1:30 p. m.	12:01 p. m.	22	22.5	90	.....	48
				24	Solar halo, 22°	8:31 a. m.	9:00 a. m.	8:15 a. m.	22	22.5	180	.....	20
				25	Parhelion, 22°, right.	8:30 a. m.	10:10 a. m.	8:35 a. m.	.....	.....	.....	27	24
				25	Parhelion, 22°, right.	.....	.....	9:55 a. m.	.....	.....	.....	33.5	36
				25	Parhelion, 22°, left.	9:45 a. m.	10:10 a. m.	9:55 a. m.	.....	.....	.....	33.5	36
				25	Circumzenithal arc.	7:45 a. m.	8:30 a. m.	8:15 a. m.	23.5	24.5	40	46	20
				25	Parhelic circle.	9:45 a. m.	10:10 a. m.	9:55 a. m.	.....	.....	77	.....	36
*Ellendale, N. Dak.	444	45 59	98 34	14	Solar halo, 22°	7:15 a. m.	8:10 a. m.	7:22 a. m.	23	23	100	.....	13
*Groesbeck, Tex.	141	31 30	96 28	3	Solar halo, 22°	10:14 a. m.	10:26 a. m.	10:22 a. m.	30	22	.....	.....	52
				11	Solar halo, 22°	11:15 a. m.	4:13 p. m.	11:27 a. m.	21.1	22	315	.....	60
*Leesburg, Ga.	85	31 47	84 14	12	Lunar halo, 22°	6:42 p. m.	7:25 p. m.	.....	.....	.....	.....	.....	.....
Madison, Wis.	297	43 05	89 23	1	Solar halo, 22°	5:20 p. m.	.....	.....	.....	.....	.....	.....	.....
				13	Solar halo, 22°	9:05 a. m.	10:00 a. m.	.....	.....	.....	.....	.....	.....
				23	Solar halo, 22°	5:00 p. m.	Sunset.	.....	.....	.....	.....	.....	.....
				24	Solar halo, 22°	12:00 m.	1:30 p. m.	.....	.....	.....	.....	.....	.....
				24	Circumscribed halo.	12:00 m.	1:30 p. m.	.....	.....	.....	.....	.....	.....
Nashville, Tenn.	166	36 10	86 47	4	Solar halo, 22°	11:50 a. m.	12:05 p. m.	.....	.....	.....	.....	.....	.....
				27	Circumscribed halo.	11:05 a. m.	1:00 p. m.	.....	.....	.....	.....	.....	.....
				28	Solar halo, 22°	10:00 a. m.	10:10 a. m.	.....	.....	.....	.....	.....	.....
*Royal Center, Ind.	225	40 53	86 29	None.	.....	.....	.....	.....	.....	.....	.....	.....	.....

* Aerological station.

HALO PHENOMENA OBSERVED DURING SEPTEMBER, 1918.

Station.	Date.	Colors.†	Degree of brightness.	Clouds.			Station pressure.	Precipitation.	
				Amount.	Kind.	Dir.		Last previous ended.	First subsequent began.
*Broken Arrow, Okla.	11	R.	Bright	9	Ci. St.	w.	Falling	10:00 a. m., 6th.	6:57 a. m., 15th.
				4	Ci. St.	nw.			
	11	R.	Dim	3	A. st.	nw.	Stationary	10.00 a. m., 6th.	6:57 a. m., 15th.
	13	Y.	Dim	8	Ci. st.	n.	Rising	10:00 a. m., 6th.	6:57 a. m., 15th.
	13		Dim						
	13		Dim						
	13		Dim						
Canton, N. Y.	6	R. G.	Dim	1	Ci. st.	w.	Rising	8:00 a. m., 6th.	D. N., a., 10th.
				7	A. st.	w.			
	7		Bright	1	Ci.	w.	Rising	D. N., p., 6th.	D. N., a., 10th.
				3	Ci. st.	w.			
	11	O. G.	Dim	1	Ci. st.	w.	Falling	D. N., a., 10th.	9:30 p. m., 11th.
				6	A. st.	w.			
	18		Dim	1	Ci. st.	w.	Falling	—— p. m., 17th.	1:00 p. m., 18th.
	25		Dim	1	Ci. st.	w.	Falling	8:45 a. m., 24th.	8:01 p. m., 25th.
Cincinnati, Ohio.	2	R. O. Y. G. V.	Dim	6	Ci. st.	w.	Falling	8:45 a. m., 31st.	2:35 p. m., 2d.
	26	R. O. Y. G. V.	Bright	8	Ci. st.	sw.	Rising	9:10 p. m., 19th.	7:55 p. m., 30th.
Dayton, Ohio.	2	R.	Bright	8	Ci. st.	w.	Falling	9:15 a. m., 31st.	6:20 p. m., 2d.
	2	R.	Bright						
	25		Dim	5	Ci. st.	w.	Falling	11:15 a. m., 21st.	5:20 p. m., 30th.
	26		Dim	7	Ci. st.	w.	Rising	11:15 a. m., 21st.	5:20 p. m., 30th.
*Drexel, Nebr.	1	R.	Bright	7	Ci.	wnw.	Falling	9:58 a. m., 30th.	4:57 p. m., 1st.
	17	R. O. B.	Dim	7	Ci. st.	w.	Falling	6:18 a. m., 15th.	1:41 p. m., 17th.
	23	R. B.	Bright	3	Ci.	wsw.	Falling	7:20 p. m., 18th.	2:35 p. m., 24th.
				4	Ci. st.	wsw.			
	24	R. O. Y. G. B.	Dim	8	Ci. st.	sw.	Falling	7:20 p. m., 18th.	2:35 p. m., 24th.
	25	R. O. Y. G. B.	Bright	5	Ci. st.	wsw.	Rising	7:20 a. m., 25th.	1:30 p. m., 25th.
	25								
	25	R. O. Y. G. B.	Bright						
	25	R. O. Y. G. B.	Bright						
	25	W.	Dim						
*Ellendale, N. Dak.	14	R.	Bright	3	Ci. st.	wnw.	Falling	2:50 p. m., 6th.	4:30 p. m., 14th.
				5	A. st.	wnw.			
*Groesbeck, Tex.	3	O. Y. G. B.	Dim	3	Ci.	n.	Falling	11:14 a. m., 31st.	9:02 a. m., 4th.
	11	R. O. Y. G. B. V.	Brilliant	7	Ci. st.	ne.	Falling	D. N., a., 6th.	2:44 p. m., 19th.
*Leesburg, Ga.	12		Dim	4	Ci. st.	n.	Rising	10:30 a. m., 8th.	11:50 a. m., 20th.
Madison, Wis.	1	R.	Dim	8	Ci. st.	w.	Stationary	5:30 p. m., 30th.	9:15 a. m., 2d.
	13	R.	Brilliant	8	Ci. st.	nw.	Stationary	9:00 a. m., 12th.	6:43 a. m., 14th.
				Few.	Ci. Cu.	nw.			
	23	R.	Dim	10	Ci. st.	nw.	Stationary	8:25 a. m., 19th.	2:00 p. m., 29th.
	24		Brilliant	5	Ci. st.	w.	Falling	8:25 a. m., 19th.	2:00 p. m., 29th.
	24		Brilliant						
Nashville, Tenn.	4		Dim	5	Ci. st.	w.	Falling	7:15 p. m., 3d.	1:30 p. m., 4th.
	27	O. B.	Bright	5	Ci. st.	0	Falling	7:40 p. m., 26th.	
	28		Dim	10	Ci. st.	0	Falling	7:40 p. m., 26th.	
*Royal Center, Ind.	None.								

* Aerological station.

†Beginning with part nearest sun or moon: R., red; O., orange, etc.

CAPT. SCHROEDER ESTABLISHES WORLD ALTITUDE RECORD.

[Abstract from Aerial Age Weekly, New York, Oct. 14, 1918, vol. 8, no. 5, p. 224.]

The Contest Committee of the Aero Club of America has homologated the world's altitude record made by Capt. R. W. Schroeder, in a Bristol fighter equipped with 300-horsepower Hispano-Suiza motor, of 28,900 feet (8,809 m.) above sea level, during a flight on September 18, 1918, at Wilbur Wright Field, Fairfield (near Dayton), Ohio.

Nothing was more fitting. While the allies' aviators overseas are beating the Germans on the various fronts, an American aviator, Capt. R. W. Schroeder, United States Air Service, beats the German aeroplane altitude record.

Capt. Schroeder left the ground at 1:45 p. m., September 18, 1918, and reached his highest point in 105 minutes, which would have been at about 3:30 p. m. It took him about 20 minutes to descend, landing about 200 miles from where he started, at about 3:50 p. m.

Capt. Schroeder is in charge of all performance tests at the Wilbur Wright Station and his duties require him to go to 21,000 and 22,000 feet quite often, and he generally goes without oxygen. In this record climb, he got along well up to 25,000 feet without oxygen. He used no antifreezing mixture and his maximum water temperature was 85° C. at the start and minimum 60° C. at the highest altitude. The temperature of the air was −32° C. (241° A.).

The reports, including the two barograph charts,[1] duly calibrated and corrected, the performance curves, and the temperature record were certified to by Lieut. George B. Patterson, O. I. C. Performance Tests Reports, and the instruments were calibrated by the Bureau of Standards, and adjusted locally at the McCook Field Laboratory and personally installed on the aeroplane by Lieut. Patterson.

The previous American altitude record was made by Caleb Bragg at Mineola, L. I., September 20, 1917, in a Wright-Martin, Model V machine, when he reached the altitude of 20,250 feet, and the last world's record of the International Aeronautic Federation made by G. Legagneux in France on December 28, 1913, was 6,120 meters (20,258 feet). In July, 1914, a German aviator was reported as having flown to 26,200 feet, but the record was never submitted for homologation.

This world's record, made by Capt. Ruddy W. Schroeder, is the first world's aeroplane altitude record held by an American since the world's altitude record made by Lincoln Beachey, at Chicago, Ill., during the international meet, August 20, 1911, when he reached the height of 11,642 feet (3,548 meters).

[1] These are reproduced in Aerial Age Weekly for October 21, 1918, p. 314, and indicate an atmospheric pressure of close to 10 inches, or only slightly more than one-third the surface pressure.—ED.

HALO OBSERVATIONS AT YORK, N. Y.

By MILROY N. STEWART, Cooperative Observer.

[Dated: York, N. Y., Oct. 10, 1918.]

Table 1 is in continuation of a similar table in the REVIEW for September, 1915, **43**:444. Nearly all the lunar halos have been observed between 8 p. m. and 11 p. m., with nearly full moon. This will account, at least in part, for the few observed during the summer months.

Since January 10, 1917, the angular measurements have been made with an anglemeter, a modified sextant with one mirror, or, on a few occasions, with a Hadley's reflecting quadrant. All observations with this latter instrument have been made at Rochester, N. Y., 26 miles north-northeast, and have been confined to phenomena other than the usual 22° halo. Twenty-two degree halos are nearly always visible simultaneously at York and Rochester, but the attending phenomena frequently differ. The two instruments are of about the same accuracy for this type of observations.

TABLE 1.—*Number of halos observed at York, N. Y.*

[Lat. 42° 52′ 30″ N., longitude 77° 53′ W.]

A. SOLAR HALOS.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1909 to 1914, inclusive	24	27	36	24	27	22	21	18	24	26	15	14	278
1915	7	2	2	3	2	7	9	7	8	3	4	5	59
1916	10	7	11	8	9	7	7	7	4	8	5	8	91
1917	6	8	8	9	6	11	7	7	4	7	3	7	83
Totals	47	44	57	44	44	47	44	39	40	44	27	34	511
Means	5.2	4.9	6.3	4.9	4.9	5.2	4.9	4.3	4.4	4.9	3.0	3.8	57
Smoothed means	4.8	5.3	5.6	5.2	5.0	5.0	4.8	4.5	4.2	4.3	3.7	3.9	....

B. LUNAR HALOS.

1909 to 1914, inclusive	8	5	7	3	5	1	1	1	1	4	9	10	57
1915	1	0	2	1	1	0	0	1	3	1	3	4	15
1916	4	2	1	1	2	0	0	0	0	0	1	0	11
1917	1	1	2	1	0	0	0	2	0	0	1	4	12
Sums	14	8	12	6	8	1	1	4	4	5	14	18	95
Means	1.6	0.9	1.3	0.7	0.9	0.1	0.1	0.4	0.4	0.5	1.6	2.0	10.5
Smoothed means	1.5	1.2	1.0	0.9	0.6	0.3	0.2	0.3	0.4	0.8	1.0	1.8	....

During 1916 and 1917, 88 per cent of all solar halos observed were followed by precipitation within 60 hours. The average interval has been as follows:

	Hours.
1909 to 1915, inclusive	20.4
1916	20.5
1917	20.8
1909 to 1917, inclusive	20.45

For lunar halos from 1909 to 1917, inclusive, the average interval has been 16.1 hours.

Aside from the common 22° halo the following phenomena have been observed within the past two years:[1]

1916.

Nov. 11. 3:10 p. m. Circumzenithal arc.

1917.

Jan. 8. 6.50 a. m. South paraselene. Showed red and green. Measured 22° 20′ to red. Vertical light pillar upward from moon at same time.

Mar. 21. 4:45 p. m. Circumzenithal arc. 26° from top of 22° halo to to middle of spectrum.

Apr. 8. Circumzenithal halo of the 22° halo. South parhelia, part of parhelic circle, and right infralateral tangent arc of the 46° halo. (*See* MONTHLY WEATHER REVIEW, May, 1917, **45**:207.)

June 25. 5:35 p. m. Circumzenithal arc. About a quadrant visible. Lasted 5 minutes. 46° from sun.

Aug. 13. 7:00 a. m. Circumzenithal arc. 48.5° from sun; measured between red and green.

Aug. 25. 9:35 a. m. Upper tangent arc of 22° halo.

Nov. 25. 3:00 p. m. Halo having horizontal radius of 23° 20′ by sextant measurement. Vertical radius was less—about 22°.

Nov. 27. 2:45 p. m. Top of 22° halo; circumzenithal arc; and arcs of the 46° halo (?) which were at about the same height above horizon as was the top of the 22° halo. Spectrum colors showed faintly in the northerly arc. At 3 p. m. the solar distance of the top (blue) line of the circumzenithal arc was 47° 40′.

[1] For the early part of 1916 see the REVIEW for September, 1916, **43**:445.

SECTION II.—GENERAL METEOROLOGY.

CLOUDS AND THEIR SIGNIFICANCE IN LOCAL WEATHER FORECASTING.

By ANDREW H. PALMER, Meteorologist.

[Dated: Weather Bureau, San Francisco, Cal., Aug. 15, 1918.]

The significance of clouds in weather forecasting has been tested by various investigators. In general, it has been found that when clouds are considered without regard to their direction of movement or velocity of motion little information regarding the subsequent weather is indicated. When the direction from which they move and their velocity are considered, however, the significance of clouds in weather forecasting is of considerable importance in a region of cyclonic control. Particularly is this true on the Pacific coast of the United States, where, because of the impossibility of securing current data from the vast expanse of ocean to the west, every suggestive bit of information concerning the movement of cyclones is desired. Moreover, it is the writer's opinion, based upon various periods of residence in widely separated portions of the country, that everywhere within the United States the best opportunity offered the local forecaster successfully to amplify and to improve upon the district forecast is found in careful observation and interpretation of the local clouds, as a supplement to what will always be the more important guide—namely, the barometric distribution, with the recent changes in pressure.

In order to test the significance of clouds in weather forecasting and to determine the probability of precipitation and temperature changes following the various kinds of clouds at San Francisco, nine years of records, those of 1906 to 1915, have been examined. The data serving as the basis for this study are selective in the following respects: (1) Only data for the winter half year, November–April, inclusive, have been used. (2) Only the cloud observations taken as a part of the regular evening observations have been examined with respect to the subsequent weather. The necessity for thus limiting the data will be made evident from the following statement of facts:

San Francisco (latitude 37° 48′ N., longitude 122° 23′ W.) is situated upon a peninsula 7 miles in width, south of the entrance to, and west of the main portion of, a large bay of the same name. It is on a coast which runs northwest to southeast. Its mean annual temperature is 54.9°, and its mean annual precipitation is 22.27 inches. It is subject to a marine régime in climate, with small diurnal and annual ranges in temperature. Located on the northern border of the "horse latitudes," it receives about 91 per cent of its precipitation during the six months November–April, inclusive. During the nine years forming the basis of this study, 34 per cent, or practically one-third of the days during the winter half-year were rainy days—that is, days with 0.01 inch or more of precipitation. Snow rarely occurs, there being but three instances of snowfall during the nine years, and the greatest amount during that period measured but 0.04 inch in water when melted. The cyclonic control is dominant during the winter only. As the regular observations are taken at 4:50 a. m. and 4:50 p. m., local mean solar time, the morning observations are usually taken in the darkness of night during the winter, rendering the cloud observations at that hour so difficult, and subjecting them to such large probabilities of error, that they can not safely be used in any critical study. Though based principally upon San Francisco data, the conclusions are doubtless applicable throughout all that portion of the United States subject to cyclonic control of the weather, and that includes the greater portion of the country.

CIRRUS AND CIRRO-STRATUS CLOUDS.

The highest clouds are of the cirrus and cirro-stratus type. During the international "cloud-year," 1896–97, special cloud observations were taken throughout the civilized world. At the Central Office of the Weather Bureau in Washington a total of 3,978 observations of clouds were taken during that year. In this series the average height of cirrus clouds during winter was found to be 9.51 kilometers (31,200 feet, or approximately 6 miles), while that for cirro-stratus clouds was 9.53 kilometers (31,300 feet, or approximately 6 miles). Washington and San Francisco are in practically the same latitude, and it is probable that the general characteristics of clouds are similar in the two places during the winter half-year. The maximum height at which either kind of cloud was observed was 16.46 kilometers (54,000 feet, or approximately 10 miles), while the minimum height was 4.93 kilometers (16,200 feet, or approximately 3 miles). It is apparent from these figures that cirrus and cirro-stratus clouds are found only at high levels, so high, in fact, that they are above the lower limit of permanent freezing temperatures. The particles composing the clouds are usually, if not always, solid, often in the form of hexagonal prisms of ice.

In velocity the average for all cirrus clouds measured was 35 meters per second (78.3 miles per hour), while that for cirro-stratus cloud was 30 meters per second (67.1 miles per hour). The most rapidly moving cirrus clouds were traveling at a rate of 80 meters per second (179 miles per hour). As indicated by these figures, cirrus and cirro-stratus clouds usually show rapid movement. When any clouds are moving with unusual rapidity observers in the Weather Bureau are expected to include in their telegrams an indication of this fact. On account of the great height the velocity of clouds of this type is often underestimated by observers, and, as a result, they are seldom reported as moving with more than ordinary rapidity. It should be remembered that on account of the height of these clouds any apparent motion at all is an indication of considerable movement, and where the apparent motion is easily perceptible the actual movement is proportionately high. With the possible exception of certain mountain regions there is, on the average, a more or less uniform increase in the wind velocity with height throughout the United States, up to the levels of the highest clouds. During most of the time this is true regardless of the presence or absence of clouds.

Though cirrus and cirro-stratus clouds are apparently at times associated with anticyclones, they are typical

accompaniments of cyclones. If a longitudinal section were made through the vertical axis of a typical cyclone, and parallel to its direction of progression, the cirrus and cirro-stratus sheet forming the topmost portion would extend forward from the center a long distance, and backward a shorter distance. In the sequence of events which usually precede cyclonic precipitation, clouds of this kind are ordinarily the first sign, often occurring many hours before the barometer begins to fall, or before any other indication of the coming storm makes its appearance. The significance of the fringe of cirrus and cirro-stratus clouds surrounding the cyclone is often the object of inquiry among mariners, to whom a storm is often of great concern.

Table 1 is a summary of the weather conditions following cirrus and cirro-stratus clouds observed at San Francisco during the nine years, with the limitations outlined above. All cirrus and cirro-stratus clouds covering 0.1 or more of the sky at the time of the observation are included in the table, which embraces 359 cases. The weather following is computed in terms of the per cent of frequency of occurrence, and is given for all directions where the cases number five or more. Before discussing the table in detail attention should be called to one fact. High clouds can necessarily be observed only when not obscured by lower clouds. If it were possible to include data of these clouds even when they are obscured by lower clouds it is not unlikely that their significance would be enhanced.

TABLE 1.—*Weather conditions following cirrus and cirro-stratus clouds.*

Clouds moved from—	Number of cases.	Precipitation followed.		Temperature changed within 24 hours.		
		Within 24 hours.	Within 36 hours.	Less than 4°.	4° or more warmer.	4° or more colder.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent*	*Per cent.*
N.	14	7	7	72	14	14
NE.	12	0	8	84	8	8
E.	1					
SE.	0					
S.	7	29	29	100	0	0
SW.	48	31	40	60	10	30
W.	132	20	27	60	17	23
NW.	116	12	22	73	12	15
Calm.	29	10	28	66	17	17

As is indicated in Table 1, cirrus and cirro-stratus clouds moving from some direction in the southwest quadrant of the compass are far more indicative of precipitation than are those from any other quadrant. Moreover, clouds of this type which show no apparent motion have a high degree of probability in forecasting precipitation, though the rainfall may be long delayed. In general, it may be said that clouds showing a relatively high velocity indicate that the movement of the storm is relatively fast, and vice versa. This fact influences the time of the beginning as well as the time of the ending of the rainfall following. Though not shown in the table, the observations also indicate that when the winds aloft, as shown by the movement of the higher clouds are from a southwesterly direction and relatively high in velocity, high southerly winds may be expected at the surface in 4 to 12 hours. What is known as windy cirrus (cirrus ventosus), a cirrus cloud of much tangled fibers, is indicative of violent convection. In San Francisco high velocities aloft are not communicated to the surface stratum when they are from any quadrant other than southwest. However, this is probably a local condition, as observations in other parts of the United States show that the high northwest winds usually found at the rear of a typical winter cyclone are generally heralded by swiftly moving cirrus and cirro-stratus clouds from a northwesterly direction. Moreover, there is little or no relation apparent between the direction from which cirrus clouds move and the total amount of precipitation following. While discussing the direction of movement of these clouds attention should be called to the relatively small number of cases of those moving from an easterly point. Of the 359 cases of cirrus and cirro-stratus clouds observed, only 13 cases, or less than 4 per cent of the total, were found of clouds of this type crossing the meridian from an easterly point. In view of this fact it behooves observers to take special care in reporting clouds of this kind as moving from an easterly direction. When instances of this nature are encountered accuracy demands that additional observations be taken in order that no mistake be made.

As far as temperature changes are concerned, cirrus and cirro-stratus clouds were found to have little significance at San Francisco. Because of its semimarine environment marked temperature changes during a period of 24 hours are uncommon. Adopting arbitrarily a change of four degrees as a tenperature change, it was found that when all cirrus and cirro-stratus clouds were included regardless of direction of movement, two-thirds of the cases were followed by no temperature change within 24 hours. Of the several directions, however, cirrus and cirro-stratus clouds moving from the west or southwest were most frequently followed by a temperature change. When, following cirrus or cirro-stratus clouds from any direction, the change occurred within 24 hours, it was more often negative than positive.

Another word of caution regarding the observation of clouds may properly be interpolated at this point. Great care should be exercised by the observer to avoid confusing a developing or a vanishing filament of cloud with the true movement of the cloud itself. When cirrus clouds take the form of long bands or streamers radiating from a distant focal point, the cloud proper may be moving in the direction toward which the streamers point, but not necessarily so. When such a point of convergence is followed by a stratiform cloud which becomes lower and lower as it progresses, and the barometer shows an unquestioned downward tendency, it may safely be concluded that a cyclonic storm is following. On the other hand, if such a focal point is followed by broken cloud, and perhaps blue sky, fair weather is indicated. This suggests a point which the forecaster can not overestimate in importance. Cloud observations can not alone serve as a basis of forecasting. But when considered in conjunction with the various other phenomena which usually herald the approach of a cyclone they are a contributory factor which can not be neglected. Most weather changes occur in cycles. An experienced meteorologist is able to determine the various stages in this sequence of events. Moreover, a careful observer is able not only to recognize the genus of cloud, but further to differentiate each genus into its several species.

At San Francisco, as well as elsewhere in the United States, it is comparatively easy to distinguish between various species of cirrus clouds, and to designate which are most frequently followed by weather changes, and which are not. Cirrus clouds exhibit such great variety in appearance as well as in structure that the conditions which produce and sustain them must be of many different kinds. Photography has shown that true cirrus and

cirro stratus clouds are always fibrous in structure, though this is not always apparent to the naked eye. Furthermore, when clouds of this type exist at two or more different levels, often traveling in different directions, it is a sign of unstable conditions aloft, and is usually followed by unsettled weather. Always high in the atmosphere, cirrus and cirro-stratus clouds present a rudy afterglow, thus prolonging the twilight.

Other facts affecting the significance of these clouds are worthy of note. Cirro-stratus cloud is more often followed by precipitation than is cirrus, largely because it marks a later stage in the sequence of events of cyclonic origin. Moreover, solar and lunar halos obtain their significance as weather signs because they are always formed in clouds of this type. The particular species of cloud in which they form has aptly been termed cirro-nebula (cirrus-veil). Though a stratiform cloud, it is much attenuated, and produces the most conspicuous halos when it is itself almost invisible, and gives the sky a faint, milk-white appearance. Partly because of the low temperatures prevailing in the plane of cirrus and cirro-stratus clouds, the actual amount of water carried in suspension in these clouds is never large, and can never produce a measurable amount of precipitation at the ground. Though wisps of falling ice crystals may often be observed at the rear of swiftly moving cirrus clouds, they never give measurable precipitation. Again, because of the low temperature the vapor condensed to form clouds of this type passes directly from the gaseous state to the solid form, thus explaining the crystalline structure of the constituent particles, and the fact that the prismatic colors of the halos are always arranged with the red on the inside. In general, cirrus and cirro-stratus clouds are somewhat higher in summer than in winter, while they move with a considerably higher average velocity in winter than they do during the summer half year.

CIRRO-CUMULUS CLOUDS.

Cirrus and cirro-stratus clouds are ordinarily considered as one and the same type of cloud, since they exhibit similar characteristics, and the one is simply a stratiform type of the other. Cirro-cumulus clouds, however, are somewhat different, and properly form a class by themselves. Often giving rise to what is popularly called a "mackerel sky," they form the basis of many weather proverbs. When visible in the late afternoon and evening they contribute largely to the brilliancy of sunset, and help to prolong the twilight.

The average height in winter of cirro-cumulus clouds as determined from the Washington observations was 7.41 kilometers (24,300 feet, or approximately 4½ miles). The highest clouds of this type were found at 15.41 kilometers (50,600 feet, or approximately 9½ miles), while the lowest were at a level of 3.07 kilometers (10,010 feet, or approximately 2 miles). It is thus apparent that cirro-cumulus, like cirrus and cirro-stratus, are high-level clouds, so high that the visible particles constituting the cloud are usually, if not always, in the solid state. As they are found only at levels above that of permanent freezing temperature, the water must have passed directly from the gaseous to the solid state. Though considerably lower in average height, cirro-cumulus clouds were found to have about the same average velocity as that of cirrus and cirro-stratus clouds, namely, 33 meters per second (73.8 miles per hour).

TABLE 2.—*Weather conditions following cirro-cumulus clouds.*

Clouds moved from—	Number of cases.	Precipitation followed.		Temperature changed within 24 hours.		
		Within 24 hours.	Within 36 hours.	Less than 4°.	4° or more warmer.	4° or more colder.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
N.	2	.....	.....	.....	.....	.....
NE.	0	.....	.....	.....	.....	.....
E.	0	.....	.....	.....	.....	.....
SE.	3	.....	.....	.....	.....	.....
S.	0	.....	.....	.....	.....	.....
SW.	14	36	50	64	7	29
W.	19	42	53	58	21	21
NW.	21	19	29	72	14	14
Calm.	3	.....	.....	.....	.....	.....

Table 2 is a summary of the weather conditions following 62 cases of cirro-cumulus clouds observed at San Francisco during the nine years. When classified as to direction of movement it was found that one-half of the instances of cirro-cumulus clouds from the southwest were followed by precipitation within 36 hours, while more than one-half of those moving from the west were followed by rain within that period of time. Those moving from the northwest were followed by rain but 29 per cent of the time. Cirro-cumulus clouds showing no apparent movement, or moving from any direction other than from those mentioned, were infrequent. It appears that weather proverbs which state that rain is likely to follow a "mackerel sky" have considerable basis in fact, provided that the clouds are moving from the west or southwest.

Temperature changes follow cirro-cumulus clouds more frequently than they do cirrus or cirro-stratus clouds. Cirro-cumulus clouds moving from the west were followed by temperature changes almost one-half of the time, being as often positive as negative. Those moving from the southwest were followed by negative changes far more frequently than by positive changes.

Certain other facts observed in connection with cirro-cumulus clouds are noteworthy. Clouds of this type are of infrequent occurrence, and are never long-continued, suggesting that the causes which give rise to them are relatively feeble and short lived. Their cumulus form indicates that vertical convection must play an important part in their formation. On account of their height, however, currents ascending from the ground can not explain their origin. Moreover, the rapid horizontal movement of the air at these levels does not allow vertical convection to persist long. Vertical movements resulting from friction between adjoining strata of air moving in different directions, or at different rates, perhaps play a part in the cause of their formation. Helmholtzian waves may give rise to simple, parallel rows of cloud, or to complex arrangements when two adjacent air currents have different velocities. In general, it may be said that cirro-cumulus clouds are a sign of unstable conditions aloft, and are therefore a reasonably good sign of coming weather changes. In the usual sequence of events preceding cyclonic precipitation they mark an intermediate stage, being preceded by the higher cirrus and cirro-stratus clouds, and followed, or rather obscured, by the lower alto-cumulus and alto-stratus clouds. The sequence is in the reverse order and accelerated in time in the events following cyclonic rainfall.

ALTO-CUMULUS CLOUDS.

The Washington observations showed the alto-cumulus clouds to have an average height in winter of 3.82 kilometers (12,500 feet, or approximately 2½ miles). The highest observed were found at 10.17 kilometers (33,400 feet, or approximately 6½ miles), while the lowest were at 1.52 kilometers (5,000 feet, or approximately 1 mile). The average velocity of movement was determined to be 21 meters per second (47 miles per hour), though one observation showed a cloud to be moving at the rate of 54 meters per second (120.8 miles per hour).

Alto-cumulus is thus found at intermediate cloud levels. Though sometimes above and sometimes below the isotherm of freezing in the free air, its constituent water particles are usually, if not always, in the liquid form, as is evidenced by the following:

Optical phenomena like coronas, resulting from the passage of rays of light through thin alto-cumulus or alto-stratus clouds, have their spectrum colors arranged with the red on the outside, a fact possible with liquid particles only. Moreover, alto-cumulus and alto-stratus clouds do not ordinarily show a fibrous structure, while cirriform clouds always do. These statements are important in view of the fact that the liquid form of the individual particles is retained though they sometimes float in air well below the freezing point in temperature. Though the individual droplets thus exist in a liquid state at subfreezing temperatures, two or more droplets coming into contact may coalesce and take the solid form. If this process continues long enough the cumulus appearance is replaced by that of the stratiform type.

Table 3 is a summary of the weather conditions which followed 95 cases of alto-cumulus clouds observed at San Francisco during the period under consideration. It is apparent from the table that clouds of this kind moving from directions north to southeast, inclusive, are uncommon. Alto-cumulus clouds moving from any direction except northwest, or showing no apparent movement, were followed by rain within 36 hours at least one-half of the time. Those moving from the south were followed by rain three out of every five times.

TABLE 3.—*Weather conditions following alto-cumulus clouds.*

Clouds moved from—	Number of cases.	Precipitation followed.		Temperature changed within 24 hours.		
		Within 24 hours.	Within 36 hours.	Less than 4°.	4° or more warmer.	4° or more colder.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
N	1					
NE	1					
E	0					
SE	1					
S	5	60	60	80	0	20
SW	20	40	50	75	10	15
W	35	34	51	74	12	14
NW	22	32	41	77	14	9
Calm	10	50	50	80	0	20

The cumulus structure of this type of cloud suggests that ascending currents play an important part in causing its formation. It is a well-recognized fact that condensation resulting from ascending currents is far more likely to result in precipitation than is condensation, which results from the mixing of air masses differing in temperature or in humidity. This principle explains why clouds of the cumulus type often precede torrential rains of brief duration, while stratus clouds and fogs may persist for days without producing measurable precipitation. For this reason alto-cumulus clouds are of greater significance to the forecaster than are alto-stratus clouds of the same level.

The alto-cumulus cloud makes visible the fact that a cloud is never in a state of equilibrium. Within every cloud evaporation and condensation are constantly going on, and the particles making up the visible cloud mass are constantly forming and vanishing. A cloud diffuses solar light and heat so effectively that a body inclosed within it is subjected to light and heat radiation from all sides. When a thermograph is carried through a cloud stratum by a kite or a balloon, a wave-crest is almost invariably formed in the thermogram.

ALTO-STRATUS CLOUDS.

The average height of alto-stratus clouds during winter, as determined by the Washington observations, was 4.80 kilometers (15,000 feet, or approximately 3 miles). The average velocity, based upon observations for all seasons, was 21 meters per second (47 miles per hour).

As indicated by its name, alto-stratus is a high stratiform cloud. Though not so high as cirro-stratus, it is usually much thicker, and, unlike the latter, it frequently is the source of considerable precipitation. Its constituent particles are usually in the liquid form, though the temperatures are often below freezing. It does not usually show a fibrous structure, either to the naked eye or to the photographic plate. When a luminary like the sun or the moon is observed through thin alto-stratus cloud a corona, with the red end of the spectrum on the outside, is apparent. In the usual sequence of events between the appearance of the first cirrus streamers and precipitation it marks an intermediate stage, most frequently following alto-cumulus and immediately preceding the lower clouds which give the precipitation. If a map were drawn to show the prevailing cloud visible in all parts of a typical cyclone, alto-stratus cloud would form a broad ring nearly concentric with the isobars, and immediately surrounding the area where rain was falling. This ring would be broad at the front and narrow at the rear.

Table 4 is a summary of the weather conditions which followed the observation of 156 cases of alto-stratus clouds at San Francisco during the nine years. The relative infrequency of this kind of cloud moving from north to southeast, inclusive, indicates that the indraught in the immediate front of a cyclone does not ordinarily reach to alto-stratus levels. Moreover, the probability of rain following the appearance of this kind of cloud is considerable. It is greatest for clouds moving from south or southwest, those from these directions having been followed by rain more than one-half of the time. The probability of rain decreases as the direction from which the clouds move approaches north. Furthermore, the rain is far more likely to occur during the 24-hour period immediately following the observation of the cloud than it is during the subsequent 12-hour period. Though not indicated in the table, it was observed that the amount of precipitation received after the appearance of these clouds moving from the south or southwest was usually heavy, a half inch or more of rain within 24 hours having been considered heavy. Those moving from any other direction were followed by rains only light or moderate in amount.

TABLE 4.—*Weather conditions following alto-stratus clouds.*

Clouds moved from—	Number of cases.	Precipitation followed.		Temperature changed within 24 hours.		
		Within 24 hours.	Within 36 hours.	Less than 4°.	4° or more warmer.	4° or more colder.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
N.	1	.....	.....	.....	.....	.....
NE.	1	.....	.....	.....	.....	.....
E.	2	.....	.....	.....	.....	.....
SE.	3	.....	.....	.....	.....	.....
S.	10	60	60	70	0	30
SW.	34	50	56	75	6	19
W.	55	33	44	76	13	11
NW.	34	24	32	94	3	3
Calm.	16	44	44	57	12	31

The significance of alto-stratus clouds regarding subsequent temperature changes is worthy of attention, particularly of those clouds showing no apparent movement, which were followed by temperature changes almost one-half of the time. These changes were far more frequently negative than positive.

Certain other considerations associated with alto-stratus clouds present themselves. Measurable amounts of precipitation do not ordinarily occur from these clouds unless they are of considerable thickness, sufficient at least to render invisible the sun or the moon, if either is above the horizon. Moreover, the density as well as the actual amount of water carried in suspension in alto-stratus clouds is considerably greater than that of the higher cirro-stratus clouds. Furthermore, the amount of water condensed and precipitated by the former is greater than that of the latter. These facts are directly dependent upon the difference in temperature between the two levels. A fall in temperature from 65° to 60° in an alto stratus cloud will give a vastly greater amount of condensation and precipitation than will a fall from 25° to 20° in a cirro-stratus cloud. Again, following the precipitation near a cyclone center, more rain may be expected as long as the alto-stratus cloud remains unbroken. When, however, the latter shows distinct breaks, without a higher cloud stratum above, no more long-continued rain may be expected from that particular cyclone.

CUMULUS CLOUDS.

The average height in winter of the tops of cumulus clouds observed in Washington was 2.28 kilometers (7,500 feet, or approximately 1½ miles), while that for the base was 1.20 kilometers (3,900 feet, or approximately ¾ mile). The tops varied greatly in level, however, taking the year as a whole. One observation showed the top of a cumulus cloud to reach a level of 6.76 kilometers (22,200 feet, or approximately 4 miles), while on another occasion it reached only 0.91 kilometer (3,000 feet, or approximately ½ mile). The average velocity of the summits was found to be 11 meters per second (24.6 miles per hour).

True cumulus clouds are more often associated with the borders of a cyclone than with its center. Usually of local formation, their vertical dimensions often exceed their horizontal. Along the immediate coast of California this type of cloud is most frequently observed during the winter months, since the strong though superficial winds of summer then render their formation impossible. Throughout the remainder of the United States, cumulus, together with strato-cumulus, are typical summer clouds, partly because the strong winds of winter prevent local heating and the ascending currents necessary to produce them. At San Francisco cumulus clouds do not often develop into cumulo-nimbus clouds, as is shown by the fact that only one thunderstorm occurs each year, on the average, and it is usually mild. In certain places within the Tropics cumulus clouds are a daily occurrence, due partly to excessive local heating and partly to the absence of strong horizontal movement. Wherever observed, cumulus clouds are of particular interest because of the information they give concerning the wind velocity aloft. Though the base of a cumulus cloud is ordinarily found in a region of comparatively calm air, the summit of the cloud often extends into a region of swiftly moving air. Under these conditions the cloud leans forward. Sometimes the increase in wind velocity with increase of height is so rapid that the cloud "loses its head"; that is, the top portion is detached from and is blown in advance of its base.

TABLE 5.—*Weather conditions following cumulus clouds.*

Clouds moved from—	Number of cases.	Precipitation followed.		Temperature changed within 24 hours.		
		Within 24 hours.	Within 36 hours.	Less than 4°.	4° or more warmer.	4° or more colder.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
N.	1	.....	.....	.....	.....	.....
NE.	2	.....	.....	.....	.....	.....
E.	0	.....	.....	.....	.....	.....
SE.	0	.....	.....	.....	.....	.....
S.	1	.....	.....	.....	.....	.....
SW.	4	.....	.....	.....	.....	.....
W.	33	52	58	79	15	6
NW.	10	30	60	80	10	10
Calm.	1	.....	.....	.....	.....	.....

Table 5 is a summary of the weather conditions following the observation of 52 cases of cumulus clouds observed at San Francisco. That they are not a common type of cloud is suggested by the fact that they were visible at the time of the evening observation but 52 times in the 9-year period. On these occasions, 83 per cent of them moved from the west or northwest. Their significance in regard to subsequent precipitation is great, as is evidenced by the fact that 58 per cent of those moving from the west and 60 per cent of those moving from the northwest were followed by rain within 36 hours. The rain is not long delayed in following these clouds, and usually consists in sporadic showers, irregularly distributed.

The significance of these clouds regarding temperature changes is not great, only about 20 per cent being followed by such changes within 24 hours.

STRATO-CUMULUS CLOUDS.

The Washington observations showed the strato-cumulus clouds to have an average height in winter of 2.40 kilometers (7,900 feet, or approximately 1½ miles). Their average velocity was 15 meters per second (33.6 miles per hour). That they are associated with more unstable conditions than are cumulus clouds is suggested by the fact that their average velocity is almost 40 per cent greater. One computation indicated a strato-cumulus cloud to have a velocity of 33 meters per second (73.8 miles per hour).

Just as cirrus and cirro-stratus are the most common of the high-level clouds, so, at San Francisco, strato-cumulus are the most frequently observed low-level clouds. This is probably true wherever cyclones control the weather. In variety of appearance, strato-cumulus

is exceeded only by cirrus. Formed only at low levels, its constituent particles are usually in liquid form, though the combination of two or more particles may produce snowflakes, when the temperatures are sufficiently low. Of itself, this kind of cloud does not give heavy nor wide-spread precipitation. Throughout most of the United States it gives only light showers in summer, and snow flurries in winter. However, it is closely associated with the true nimbus cloud of a typical cyclone, and is usually the last cloud observed immediately before, and the first cloud seen immediately after, long-continued precipitation. When observed just before sunset it has a fire-red appearance, which is replaced by an ashen gray color shortly after the sun has sunk below the horizon.

TABLE 6.—*Weather conditions following strato-cumulus clouds.*

Clouds moved from—	Number of cases.	Precipitation followed.		Temperature changed within 24 hours.		
		Within 24 hours.	Within 36 hours.	Less than 4°.	4° or more warmer.	4° or more colder.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
N.	11	18	27	82	18	0
NE.	5	40	60	40	60	0
E.	2					
SE.	13	69	100	69	31	0
S.	29	86	90	66	14	20
SW.	46	83	87	74	9	17
W.	74	39	65	73	19	8
NW.	34	32	47	71	21	8
Calm.	9	67	89	34	33	33

Table 6 is a summary of the weather conditions following the observation of 223 cases of strato-cumulus clouds at San Francisco. Again it is evident that the winds are prevailingly west. The significance of strato-cumulus clouds in regard to precipitation is unmistakable. With the exception of those moving from the north or the northwest, clouds of this type are followed by precipitation within 36 hours by far the greater part of the time. Of the 13 cases of those moving from the southeast, every one was followed by precipitation within 36 hours, while of the 29 instances of those moving from the south, 90 per cent were so followed. Though not indicated in the table, the rainfall was usually heavy when the clouds were observed to move from a southerly point.

As far as temperature changes are concerned, strato-cumulus clouds also have considerable significance. Varying with the direction of movement, 18 to 66 per cent of these clouds were followed by temperature changes within 24 hours. These changes were prevailingly positive for clouds moving from any direction except south or southwest, for which directions the changes were more often negative.

SUMMARY AND CONCLUSIONS.

Everywhere within the United States, and particularly along the Pacific coast, clouds offer the forecaster a clue to the coming weather which can not well be disregarded. Considered without respect to their direction of movement, or without relation to the other phenomena usually associated with cyclones, their significance is slight. When considered with respect to the direction from which they move, together with their relation to the more significant fact of pressure changes, they assist the forecaster to determine the relative position of the cyclone center. Clouds should enable observers to give their respective district forecasters valuable information, as well as to aid local officials in amplifying the district forecast. In the sequence of weather changes experienced with the passage of a typical cyclone, clouds aid one in establishing the stages in the series of events.

One of the principles of forecasting recognizes the fact that converging winds tend to produce precipitation, while diverging winds tend to produce clearing weather. (The former process causes ascending currents, while the latter results in descending air.) Since the wind data included in the reports of the regular observations are those at the moment of observation only, they sometimes refer to a temporary or a local condition. The movements of the clouds, being determined by the free air, are not subject to temporary fluctuations or to local peculiarities. When cloud observations are plotted, together with the other observations, on the forecast map, the relation between their movements and the barometric distribution is readily apparent under marked cyclonic control. The amount of cloud observed at any one station is of importance only in so far as it shows the local extent of the cloud-forming conditions, the greater the amount of cloud the more wide-spread the conditions which produce it, and vice versa.

In a region of uneven topography surface winds are deceptive, both in regard to direction and to velocity. Cloud observations present a means of determining the true barometric vector in such a region. From a study of almost a thousand cloud observations made at San Francisco during nine years it is apparent that the significance of clouds regarding subsequent precipitation is worthy of the forecaster's attention, the significance increasing as the height of the cloud decreases. The significance regarding precipitation varies greatly with direction at all cloud levels. For the highest clouds those moving from the southwest are most frequently followed by rain; for those of intermediate levels those from the south are so followed; while for the lowest clouds southeast is the direction of greatest significance, the probability of rain increasing as the direction changes from southwest to southeast, and the height of the cloud diminishes.

As far as temperature changes are concerned, the significance of clouds is not great at San Francisco. It is least with high clouds and greatest with low clouds, and varies greatly with direction at all levels. This fact is doubtless influenced by the semimarine environment of the city.

DISCUSSION.

Before the establishment of weather services and the systematic forecasting of the weather from synoptic charts and based upon scientific principles, clouds undoubtedly formed the best and most popular index of approaching weather conditions. They are referred to from the earliest history as premonitions of the approach of storms, and were carefully watched and studied by mariners and others to whom the future weather was of vital importance; and certain well recognized kinds of clouds were the best known index of an approaching storm.

In more recent years, with our increased knowledge of meteorology, clouds have been systematically studied and classified, and their value to the forecaster is no longer an open question. Certain kinds of clouds are almost invariably associated with certain kinds of weather, and at times when the distribution of barometric pressure and temperature and wind velocities and directions are such as to create doubt in the mind of the forecaster, the kind and amount of clouds, and the direction in which they are moving, will help him to decide upon the proper forecast to issue.

The value of the kind, amount, and direction of the clouds to the forecaster on the Pacific coast can not be overestimated. Many times the approach of a storm from the ocean is indicated by the cloud formation several hours before the pressure begins to fall or the winds change in direction and increase in force. Some of the best forecasting that I have ever seen was largely based upon the character and movement of the clouds.

In the forecasts issued from this office for the benefit of the raisin growers when drying their crop in the late summer and early fall, the value of cloud formation is pre-eminent. The conditions to be guarded against are those of unsettled weather, when scattered showers occur in the mountains and foothills and extend down into the valley. There are several types of maps which indicate these conditions, but they are not likely to produce rain unless preceded or accompanied by the rapid formation of a cumulus cap, first appearing on the eastern slope of the Sierra and later extending over the range to the San Joaquin Valley side.—*G. H. Willson, District Forecaster.*

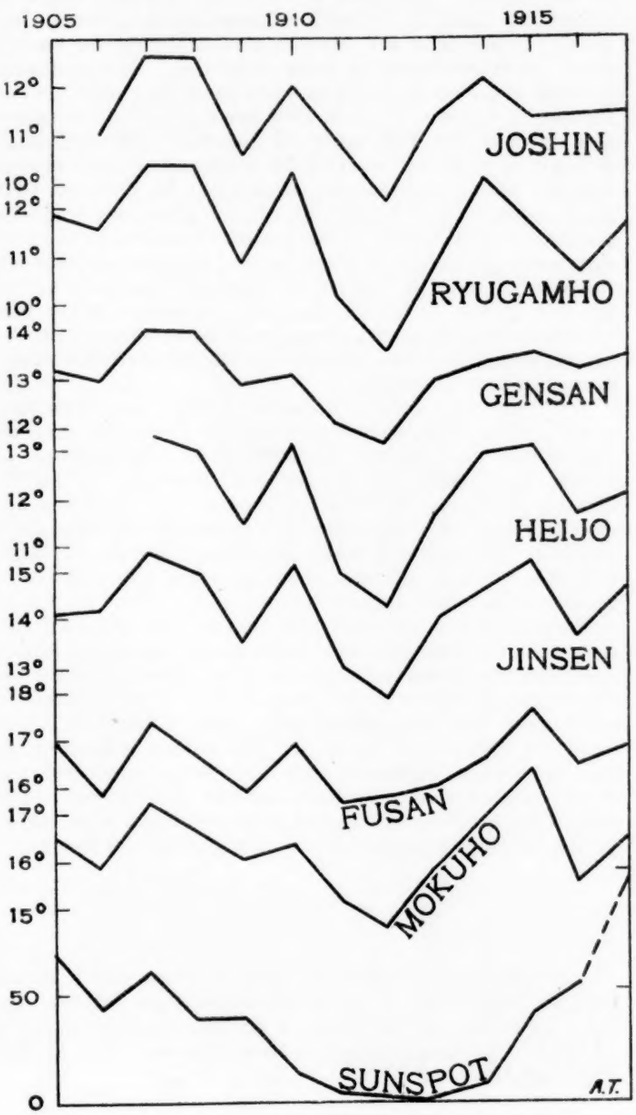

FIG. 1.—Sun-spot numbers, and October temperatures in Chosen.

SOME CORRELATIONS BETWEEN SOLAR ACTIVITY AND THE CLIMATE OF THE FAR EAST.[1]

By R. SEKIGUCHI.

1. *Solar activity and October temperatures of some parts of Chosen (Korea).*—In this report we intend to show the existence of correlations between annual sun-spot numbers and October temperatures of various parts of Chosen. A glance at figure 1 shows undeniable similarities between the general run of the curves representing variations of temperature and the curve of annual sun-spot numbers, though there are many dissimilarities if they are compared part by part. The correlation coefficients have been calculated with the following results:

		Probable error.
Ryugamho (Yongampo)	+0.39	±0.158
Gensan (Wonsan)	+0.58	±0.124
Jinsen (Chemulpo)	+0.39	±0.158
Fusan	+0.48	±0.143
Mokuho (Moppo)	+0.44	±0.150

Similar relations seem to exist throughout the wide area including not only the whole of Chosen but also the northern part of China and the eastern part of Siberia. (See fig. 2.) For instance, the correlation coefficient for Irkutsk (1886–1904) is $+0.41 \pm 0.132$, and that for Tsingtau (1898–1915, except 1914) $+0.43 \pm 0.123$.

In Chosen and Manchuria the month of October is one of the quietest seasons of the year; hence the mean temperature of that month in these regions may be consid-

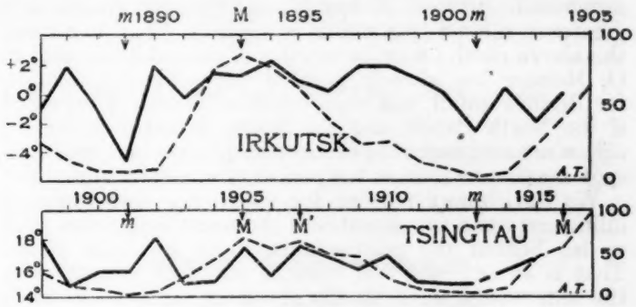

FIG. 2.—Sun-spot numbers, and October temperatures.

(Broken line=relative annual sun-spot numbers, has been supplied by the editor.)

ered to follow faithfully the general distribution of barometric pressure in the Far East, without being greatly disturbed by passing cyclones, etc., as is generally the case in the other seasons and in most parts of Japan proper. Although it may be somewhat premature to draw conclusions from the results that have been found from the observations of such a short period, we have grounds for assuming that they have the following significance: *There is a marked difference between the progress of the development of the Siberian* HIGH *in the period of sun-spot maximum and in the period of sun-spot minimum.* More definite conclusions will be obtained if correlation coefficients over more extended areas be examined. The necessary computations are now going on, and the results will be reported later.

2. *Solar activity and rainfall.*—Some statistical researches have been made to see if there be any correlation between the annual rainfall of Seoul, Chosen, and the annual sun-spot numbers. The rainfall data for the period before 1907 were taken from the table compiled by the late Dr. Y. Wada from the records of the Royal

[1] Condensed from abstract in Jour. Met'l Soc. Japan, Tokyo, July, 1918, 37:33–42.

Court of Korea,[2] and for the remaining years from the Annual Reports of the Meteorological Observatory of the Government General of Chosen. The results are shown in Table 1, which gives the frequency of each class of rainfall for each class of sun-spot numbers. The following peculiarities may be noticed:

(*a*) For annual sun-spot numbers less than 20 the frequency of each rainfall class maintains its normal proportion.[3]

(*b*) For annual sun-spot numbers 20 to 40, the frequency of the rainfall class 1,000–1,200 mm. far exceeds the natural proportion (24 per cent), while those of the remaining classes generally are below their normal proportions.

(*c*) For annual sun-spot numbers 40 to 80, frequency of the next superior and the next inferior class are fairly great, and both exceed the normal proportions (19 and 13 per cent, respectively); while the frequency of the class 1,000–1,200 mm. is less than the normal proportion, and far less than that for sun-spot numbers 20 to 40.

(*d*) When the annual sun-spot numbers exceed 80, the frequencies of two of the three above-named rainfall classes become less than they are in the case of (*c*), while those of the next inferior and the next superior classes both become greater.

In short, in years with excessive sun-spot numbers, the tendency is for the occurrence of either abnormally excessive or abnormally deficient annual rainfalls.

The above results also show that the variability of the annual rainfall at Seoul is least when the annual sun-spot numbers lie between 20 and 40, and becomes greater and greater as the sun-spot numbers increase. In this respect the above results may be worthy of special attention, as O. Meisner has already pointed out a similar relation for Berlin rainfall, and such relations would be expected if the North Pacific and the North Atlantic centers of action are assumed to be more intense in the period of sun-spot maximum than in the period of sun-spot minimum.

We have many reasons for supposing that sun-spot influences upon the climates of the temperate zones tend to lag behind the master phenomena by some years. That is to say, the full climatic effect of variations in the sun would show itself only after some years have elapsed. The amount of such time lag may be different for different regions and for different climatic elements. I have therefore examined by successive trials to see if the annual rainfall of Seoul may not be intimately correlated to the sun-spot number of some one of the preceding 5 years. It has been found that if in any year the sun-spot number be exceedingly great, the annual rainfall three years later tends to be excessive, as will be seen from Table 2.

Furthermore, if the annual rainfalls of Table 2 be divided into two classes, one including all above 900 mm. and the other all below that amount, then out of 24 cases of exceptional solar activity (annual sun-spot number 80 or more), we have only a single case of deficient annual rainfall, while out of 119 cases of lesser sun-spot numbers we have 33 cases (28 per cent) of deficient annual rainfalls. Though this result is too remarkable to be regarded as a mere chance, I will abstain from drawing any conclusion from it.

[2] The period covered by this record is not stated, but the number of relative annual sun-spot numbers equaling or exceeding 80 indicates that it extends back at least to include the year 1769.—EDITOR.

[3] Note that there is a slight tendency for above-the-normal frequencies of both extreme deficiency and extreme excess of rainfall, as is also found to be the case from the data in Table 3.—EDITOR.

I have also searched for sun-spot influences upon the rainfall of Kagoshima, Miyazaki, Oita, Nagasaki, Shimonoseki, Idsugahara, and Hiroshima, in the western part of Japan proper, for the period 1886 to 1915. For this purpose the annual rainfalls at these stations in each year, expressed as percentages of the respective normal values, have been combined into a mean value, and the deviations of this mean from 100 per cent have been computed.

In Table 3 the first column gives these deviations arranged according to the order of magnitude; the second column gives the years in which the respective deviations have occurred; and the third column, the number of years counted forward (+) or backward (−) from the nearest sun-spot maximum (M) or minimum (*m*). These results are summarized in Table 4, which shows that both the abnormally excessive and the abnormally deficient annual rainfalls tend to occur near the period of sun-spot maximum or minimum.

3. *Solar activity and cyclones.*—Statistics show that the formation of typhoons is most frequent toward the middle of September. But this is only the average state of things; in fact, the season of maximum typhoon frequency comes in some years considerably earlier and in some years considerably later than this. For instance, in 1899 typhoon formations were most frequent toward the end of August, while in 1909 the maximum frequency was toward the beginning of October. Though it is difficult to point out exactly by what causes such abnormalities are brought about, it can not be doubted that they depend to some extent on the intensity and the position of the North Pacific center of action in the late summer. Therefore, if there be any correlation between the varying solar activity and either the intensity or the position of the North Pacific center of action in the late summer, then we might expect such solar activities to be accompanied by abnormalities in the time of the maximum typhoon activity.

With this expectation in mind, Table 5 has been prepared. The data were taken partly from the Annual Report of the Central Meteorological Observatory of Japan (the barometric depressions) prepared by Dr. T. Okada, to which, through his generosity, I had the liberty to refer. To determine the period of the maximum typhoon frequency, I have proceeded as follows: Subdividing each month into three decades, the number of typhoons in each decade was counted. The arithmetical mean of the typhoon numbers of any three successive decades was adopted as representing the typhoon frequency of the middle decade of the three. From the thus determined typhoon frequencies of all decades of each year the maximum value was taken out. The results are shown in Table 5. The second column gives the maximum value of typhoon frequencies and the third column shows in what decade it occurred. The values in the fourth column were obtained from those in the preceding column by smoothing by the formula,

$$(V_n) = \frac{V_{n-1} + 2V_n + V_{n+1}}{4}$$

These values are plotted in figure 3, from which it can be seen that there is an intimate relation between the solar activity and the time of the maximum frequency of typhoon, though it is not so simple as I had at first expected it to be.

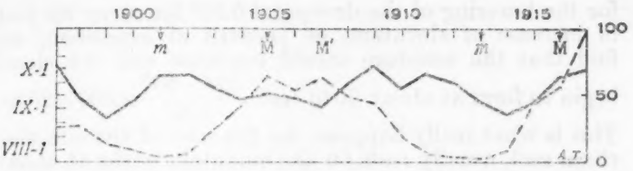

FIG. 3.—Sun-spot numbers and epochs of annual maximum typhoon frequency.

(Broken line=relative annual sun-spot numbers, has been supplied by the editor.)

As for Yang-tze-kiang cyclones, Table 6 is added to point out that there is a general tendency for the annual frequency of cyclones to decrease as the period of sunspot minimum is approached.

TABLE 1.—*Relation between the annual rainfall of Seoul and relative annual sun-spot numbers.*

Annual rainfall.	Relative annual sun-spot numbers. 0–20		20–40		40–80		80<		Total.	
	Frequency.	Per cent.	Frequency.	Per cent.	Frequency.	Per cent.	Frequency.	Per cent.	Frequency.	Per cent.
mm.										
<600	2	5	0	0	0	0	0	0	2	1
600–800	8	17	4	14	6	14	5	20	23	16
800–1000	9	19	4	14	9	20	6	24	28	19
1000–1200	11	24	10	34	9	20	4	16	34	24
1200–1400	3	7	4	14	9	20	2	8	18	13
1400–1600	6	14	3	10	4	9	4	16	17	12
1600–1800	3	7	2	7	4	9	1	4	10	7
1800<	4	10	2	7	3	7	3	12	12	8
Total.	46	.....	29	.....	44	.....	25	.....	144	.....

TABLE 2.—*Relation between relative annual sun-spot numbers and the annual rainfall of Seoul the third year after.*

Rainfall third year after.	Relative annual sun-spot numbers. 0–20		20–40		40–80		80<		Total.	
	Frequency.	Per cent.	Frequency.	Per cent.	Frequency.	Per cent.	Frequency.	Per cent.	Frequency.	Per cent.
mm.										
<600	0	0	1	4	1	2	0	0	2	1
600–1000	16	35	12	46	17	36	5	21	50	35
1000–1400	18	41	8	31	18	38	11	46	55	38
1400–1800	7	15	4	16	10	21	7	29	28	20
1800<	5	10	1	4	1	2	1	4	8	6
Total.	46	.....	26	.....	47	.....	24	.....	143	.....

TABLE 3.—*Deviation of annual rainfall in western Japan from normal, in relation to the epoch of maxima and minima of annual sun-spot numbers.*

Deviation of rainfall.	Year.	Number of years from sun-spot maximum or minimum.		Deviation of rainfall.	Year.	Number of years from sun spot maximum or minimum.	
+35	1905	M	0	−9	1897	M	+4
−23	1904	M	−1	+8	1906	M	+1
−22	1894	M	+1	+8	1912	m	−1
−20	1913	m	0	+8	1914	m	+1
+17	1890	m	+1	−6	1884	M	+1
+15	1915	M	−1	−6	1903	m	+2
+15	1885	M	+2	−5	1892	M	+1
+15	1886	M	**+3**	−5	1887	m	−2
+12	1889	m	0	−5	1898	m	−3
+11	1901	m	0	+4	1908	M	+3
+11	1902	m	+1	−4	1899	m	−2
+11	1909	M	+4	+3	1896	M	+3
+11	1911	m	−2	−3	1900	m	−1
−11	1889	m	−1	−2	1907	M	+2
−11	1893	m	0	+1	1891	m	+2
−10	1895	M	+2	0	1910	m	−3

TABLE 4.—*Deviation of annual rainfall in western Japan from normal, in relation to the epoch of maxima and minima of annual sun-spot numbers.*

	Absolute values of deviations. 0–4	5–9	10–14	≷15	0–10	≷11
Number of cases in which those deviations occurred in the years of sun-spot maxima or minima, or 1 year before or after it	1	5	5	6	6	11
The number of the other cases	6	4	3	2	11	4

TABLE 5.—*Period of annual maximum typhoon frequency.*

Year.	Maximum values of typhoon frequency.	Time of maximum typhoon frequency. Month.	Decade.	Smoothed time maximum typhoon frequency. Month.	Decade.
1897	1.0	October	First		
1898	1.0	September	Second	September	1.8
1899	1.6	August	Second	August	3.3
1900	1.6	July	Third	September	1.5
1901	1.3	October	Second	September	3.5
1902	1.6	September	Second	September	3.6
1903	2.0	September / October	Third / First	September	2.6
1904	1.3	August	Second-third	September	1.9
1905	1.6	September	Third	September	2.4
1906	2.7	September	Second	September	2.0
1907	1.6	August	Second	September	1.3
1908	2.0	September	Third	September	3.0
1909	1.6	October	Second	October	1.5
1910	1.3	September	Third	September	2.8
1911	2.0	September / October	Third / First	September	3.8
1912	1.6	September	Third	September	3.1
1913	2.3	September	First	September	1.6
1914	1.6	August	Second-third	August	3.8
1915	2.3	September	First	September	1.6
1916	1.6	September	Third	September	3.4
1917	1.0	October	First-second		

TABLE 6.—*Annual frequency of Yang-tze-kiang cyclones.*

Year.	1904	1905 (M)	1906	1907	1908	1909	1910	1911	1912	1913 (m)	1914	1915	1916	1917 (M)
Number of cyclones	15	15	8	13	9	7	7	9	4	9	10	13	10	11

CUMULUS CLOUDS OF HAWAII.

By ANDREW M. HAMRICK, Meteorologist.

[Dated: Cheyenne, Wyo., June 23, 1918.]

The cumulus clouds of Hawaii, especially those which pile up over the Koolau Mountains on the Island of Oahu, are so remarkable in their method of formation that a brief description of them may be interesting in connection with the Bureau's renewed activities in the observation of clouds and upper-air conditions.

They are not convection-formed clouds in the sense of warm air rising and expanding to maintain atmospheric equilibrium, but are the result of the moist air being *forced* upward by the prevailing Northeast Trades as they strike against the steep sides of the Koolau Mountain range. This range extends throughout the length of the Island of Oahu, and lies at right angles to the direction of the Trade winds; therefore the only course of the latter is up, and over.

As the Trade winds prevail throughout the year, the huge cloud-cap may be observed both night and day, summer and winter, except occasionally when overpowered by the "Kona" storms. The height and extent of the clouds usually depend upon the strength of the wind.

References have been made by meteorologists to the fact that cumulus clouds are often convection-formed

over islands, by the air over the ground warming more rapidly during the day than that over the oceans. I am sure this plays no important part in the formation of the clouds on Oahu because of the following reasons: (1) The mountain range closely parallels the northeastern coast of the Island, and as it is nearly always shaded by the cloud-cap the ground does not have an opportunity to warm sufficiently to cause an uprising current of air. (2) The "cloud-rack" does not disappear as night comes on, but remains unchanged in appearance so long as the Trade winds blow with sufficient velocity to force the air over the top. The fact that the greater part of Honolulu's precipitation occurs during the night hours further substantiates these statements. (3) The Island of Oahu is so narrow that a land and sea breeze is seldom, if ever, experienced thereon, and surely not at Honolulu.

for the lowering of the dew-point 0.33° for every 300 feet of increase of elevation, on account of expansion, we find that the moisture should condense and the cloud begin to form at about 2040 feet: $\frac{75°-65°}{1.47}\times 300=2040$. This is what really happens, for the base of the cumulus cloud rack usually rests on the mountain peaks at about 2,000 or 2,200 feet above sea level, although on warm days, which seldom have a temperature above 90°F., it may be at the top of the highest peak, Konahuanui, elevation, 3,100 feet.

The upper part of figure 2 shows Konahuanui (extreme left) cloud-capped, while the range to the right is below the cloud base. This photograph was taken on a warm day. The lower part of figure 2 shows the same range to the right well within the clouds, and the patches of sunshine and shadow at the base clearly show that the

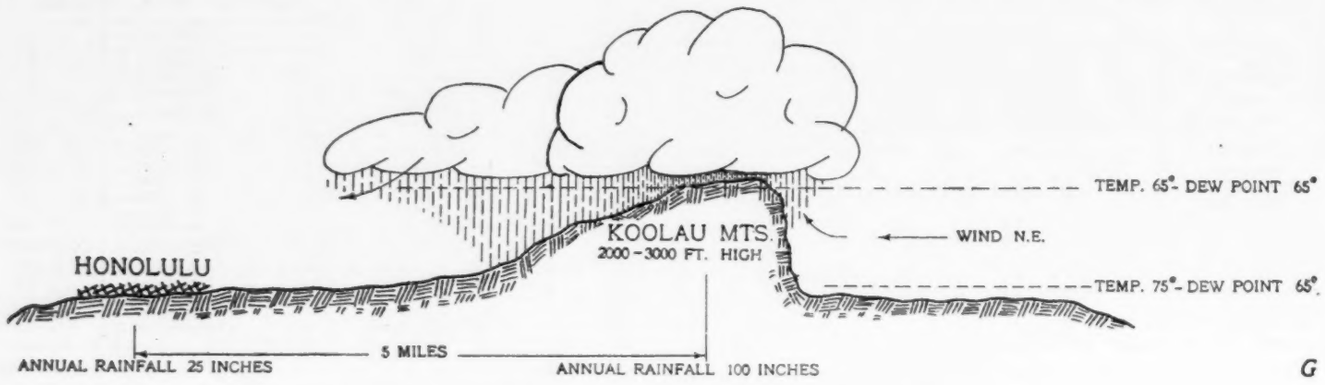

FIG. 1.—Cross section of the Island of Oahu and the cloud-cap over Koolau Mountains.

The accompanying diagram and photographs (figs. 1 to 3) in addition to showing the method of cloud formation, clearly illustrate the fact that were Oahu a low, level Island it would be but a barren desert. By a fortunate coincidence the mountain range lies in the proper direction, and it is of sufficient elevation, to cooperate with the steady Northeast Trades in extracting a bountiful supply of moisture from the heavy-laden atmosphere. This, in a measure, is true of the other large Islands of the group; although they do not all possess mountain ranges, there are points upon them ranging from 3,000 to 13,800 feet elevation above sea level. These obstruct the passage of the moisture-laden Trades, and collect sufficient water to feed constantly the irrigation ditches, upon which the greater part of the agriculture in the Hawaiian Islands depends. The smaller low-lying islands of the group are unproductive because of lack of rainfall.

Figure 1 illustrates the reasons for such large differences in the annual rainfall within very short distances. For instance, in the business district of Honolulu the average annual rainfall is about 25 inches, while 3 miles northeast of the city, or about halfway to the summit of the mountains, it is 100 inches per annum.

The Koolau Range averages from 2,000 to 3,000 feet high, and this seems to be the proper elevation, under the existing atmospheric conditions, to obtain the maximum cloud formation. From three daily sets of observations made at the top and the base of the "Pali" (precipice), (see X, X in upper part of fig. 2), the average temperature decrease was found to be 1°F. for every 165 feet of ascent. With a temperature at the base of the "Pali" of 75°, and dew-point 65°, and allowing

weather is not so ominous as a first glance would indicate. See also the upper part of figure 3, taken from the *leeward* side, looking into the wind.

With a 10 or 20 mile trade wind at the base of the range it sometimes whips over the tops of the mountains at a terrific rate, and this velocity is a determining factor in blowing the top of the "cloud-rack" far enough over to cause rain in Honolulu, even though the sun is shining brightly on that city. (See fig. 1.) Such showers are locally termed *"liquid sunshine"* and are a great source of interest to the "malihini" (stranger).

The lower part of figure 3 is a familiar view from Honolulu, and to a person entering the harbor for the first time it is a beautiful, though threatening, outlook. It appears as though a terrific thunderstorm, less than five miles away, were about to break upon him—but it never does. With the "cloud-rack" blown a little closer, the *Promise* (rainbow) comes with it, so there is no fear. The small boy in Honolulu has long since lost faith in the story of the "pot of gold at the end of the rainbow," for he has looked in *the very spot* too many times. The nearest to the "pot of gold" are the rich sugar-cane and pineapple plantations. Because of the peculiar natural setting, there is probably no place else in the world where rainbows are more often seen than in Honolulu. This is true of lunar as well as solar rainbows, for similar conditions prevail at night, and the tropical full moon brings out the colors of the rainbow in all their splendor.

Because of the excessive moisture from the cumulus clouds, vegetation in the mountains is dense and rank, impenetrable except where trails are cut.

Aviators have soared over the cloud-cap at elevations of from 8,000 to 9,000 feet, and this coincides with my

[To face page 416.]

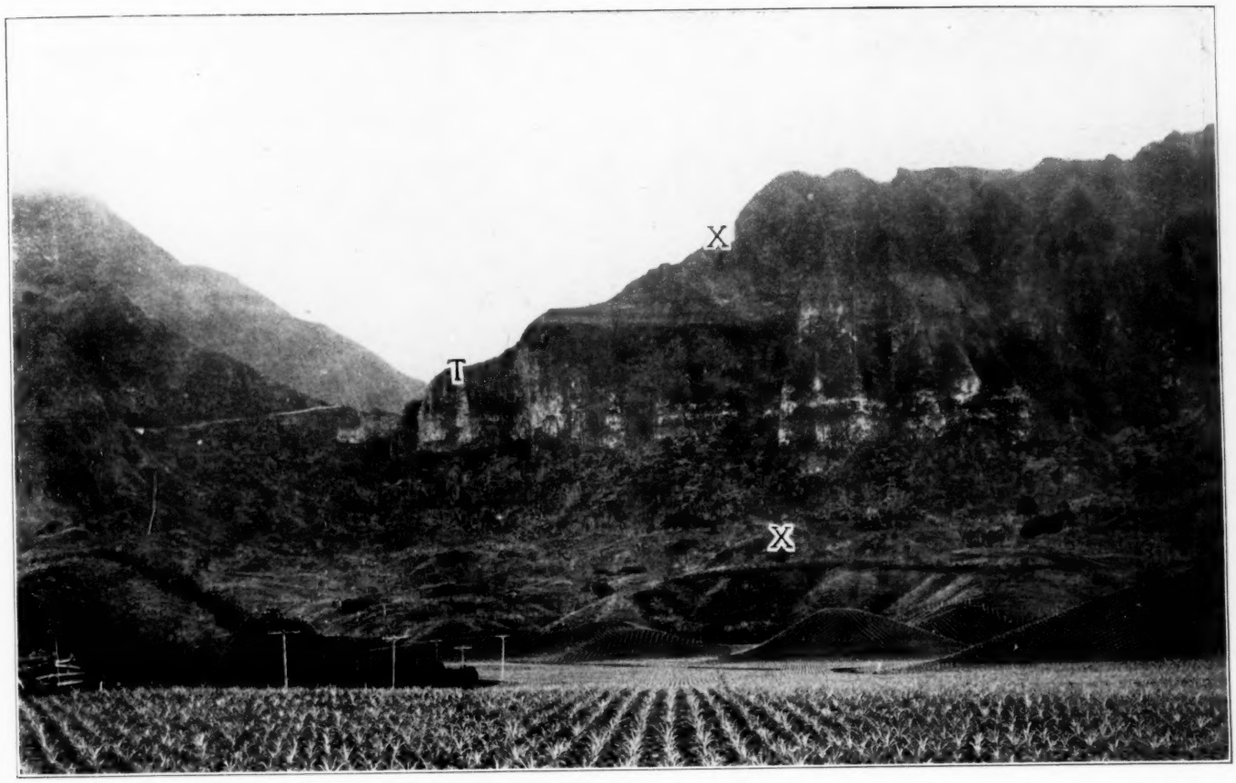

FIG. 2.—(*Upper*) Koolau Mountains, Konahuanui, cloud-capped, is on the extreme left. In the center, crosses (x, x) show points where half-hourly observations of temperature, humidity, and cloud movement were made. At point marked (T) an anemometer was installed, and it registered 60 miles of wind an hour for 5 hours; (*lower*) Cloud-cap on Koolau Mountains from windward side. (Wind from northeast.)

[To face page 417.]

FIG. 3.—(*Upper*) Cloud-cap on Koolau Mountains from leeward side, looking northeast. Taken halfway up to "Pali" from Honolulu; (*lower*) Cloud-cap on Koolau Mountains from Honolulu, looking northeast.

estimates from rough measurements that the depth of the cloud from top of dome to base is from 3,000 to 5,000 feet.

NOTE.—The type of cloud described in the foregoing article has been named *crest-cloud* by W. J. Humphreys, who says, in his "Physics of the Air" (Jour. Frankl. Inst., May. 1918, p. 635):

> The crest cloud is formed by the upward deflection of the wind by a long mountain ridge. It usually covers the higher slopes as well as the top, and though called cloud by people in the valleys below, is likely to be designated fog by any one actually in it. Occasionally condensation occurs only along the upper reaches of the deflected winds, in which case the cloud belt is above and to the leeward of the mountain ridge.
>
> In either case the individual droplets are quickly evaporated and the cloud form preserved only through continuous condensation from renewed air. It is permanent in the same sense that a cataract is permanent through the continuous supply of water by the stream above.

Identical in mode of origin with the crest-cloud is the *cap-cloud* or *cloud-cap*, formed over an isolated peak.

These clouds, due to the forced ascent, of moist air over mountains, were once known as *parasitic clouds*—a term introduced by Marcellin du Carla in his memoir "Sur les nuages parasites" (Rozier, Observations sur la physique, etc., v. 24, 1784, p. 392–399; 456–473; v. 25, 1784, p. 31–38; 94–102). This author describes the occurrence of the clouds in question in various parts of the world and endeavors to explain them as due to condensation in an updraft of air caused by the emission of subterranean heat from mountains. In the Annales de la Société d'agriculture de Lyon, v. 2, 1839, there is an account of a cloud of this type as observed on the summit of Mont Pilat, south of Lyons. ("Note sur le développement d'un nuage parasite au Pilat.") In his book on "The Mediterranean" (London, 1854), p. 235, Admiral W. H. Smyth says that during the development of the solano at Cadiz "parasitic clouds, as they are termed by meteorologists, cap the hills of Medina Sidonia."

Of the more important local examples of such clouds it is necessary to mention here only the Helm Cloud of the English Lake District, and the Table Cloth of Table Mountain, South Africa; both famous in meteorological literature.

An excellent specimen of the crest-cloud is the so-called *foehn-wall* (*Föhnmauer*), seen along the crest of an Alpine ridge over which a foehn is blowing. This is described and illustrated in Dr. F. Kerner von Marilaun's paper "Die Föhnmauer" (Ztschr. Deutsch. u. Oesterr. Alpenvereines, v. 23, 1892).—*C. F. Talman.*

SOME NEW FACTS ABOUT THE CENTERS OF TYPHOONS.

By CO-CHING CHU.

[Dated: Cambridge, Mass., June 15, 1918.]

TEMPERATURE CONDITIONS IN THE CENTER OF A TYPHOON.

No problem connected with the study of tropical cyclones is more interesting and more vital than that which concerns the "eye" of the storm. The "eye" is the central region of relative or absolute calm. The calm may last a few minutes, or more than an hour. Immediately after the period of calm, the wind at once regains its strength, and blows with hurricane force from a direction nearly or exactly opposite to that from which it came before the calm. Some years ago, Sidney M. Ballou made an investigation of the phenomenon of the eye of the storm.[1] He gave several authoritative accounts of the phenomenon as observed before 1892, and suggested the probable explanations for its existence. Since then, however, many additional accounts of the eye of the storm have found their way into the reports of the different observatories and meteorological services, and a complete analysis of these would doubtless throw much more light on the subject. The present paper can deal with only a few of the accounts which have been given in the Monthly Bulletins of the Philippines Weather Bureau during the years 1904–1915. We will discuss first the temperature conditions in the center of a typhoon.

It is to be regretted that readings of the thermometers are not always given in the reports of the phenomena associated with the passage of the eye of the storm. A knowledge of the temperature condition in the eye is necessary in order to understand many other phenomena, like the clearing of the sky, etc, which are related to the passage of the calm center.

Regarding the temperature condition of the atmosphere during the passage of the central calm in the famous Manila typhoon of October 18, 1882, Father Algué says:[2]

> When at noon on the 20th of October, 1882, Manila entered the central part of the vortex, the absolute calm, the temperature suddenly rose during its passage from 25°C. (77°F.) to 31.5°C. (88.7°F.), but fell again to its former level after the center had passed the city. This is a change which is exceptional, for no such rise was noticed either on the 5th of November, 1882, at Manila, or, as far as we know, on any other occasion. It, therefore, attacted the attention of meteorologists, and gave rise to various controversies, in which each one took the example to support his own view. Faye also made use of this change of temperature to prove the existence of descending air currents in the interior of cyclones.
>
> After a close examination of all the circumstances we will find that the temperature remained steady and comparatively low from 7 p. m. on the 19th till a little before the transit of the center—that is to say, during the time in which the rain squalls were almost incessant and the gusts of wind freshened until they reached the force of a cyclonic storm. This steady, low temperature is without any doubt to be ascribed to the showers and wind squalls. According to the regular oscillations of temperature on cloudy days, the thermometers had to fall during the afternoon of October 19, since during that month the normal temperature for 7 p. m. does not reach 26°C. (78.8°F.). After that hour the temperature decreases very slowly to 24°C. (75.2°F.) at midnight, and then remains fairly constant until 7 a. m. It is, therefore, nothing extraordinary if, from 7 p. m. of October 19 to 7 a. m. of October 20, the temperature remained slightly below 25°C. (77°F.). Usually, indeed, on cloudy days the thermometer rises between 7 a. m. and noon to 27°C. (80.6°F.), but during these hours on October 20 the winds were already more than brisk, the squalls frequent, the rain heavy and continually increasing until the entrance into the relative central calm. At this moment the dense covering of the nimbus grew lighter, the squalls ceased, the wind calmed down, the sky became almost clear; Manila was within the extended region of vortical calm of about 14–16 miles diameter. What wonder, then, that without any other cause but solar activity from a sky nearly clear, by simple radiation, the temperature rose rapidly till it reached the normal height, which is 31.5°C. (88.7°F.) for a cloudless day in October?

Discussing the same subject, Hann says:[3]

> Merkliche Änderungen der Temperatur und Feuchtigkeit im Zentrum einer Zyklone werden nur bei jener vom 20. Oktober, 1882, zu Manila angegeben, wo die Temperatur auffallend stieg und die relative Feuchtigkeit abnahm. Bisher ist kein gleicher Fall berichtet worden.

During the years 1904–1915 at least four cases of an increase of temperature during the passage of the central calm of typhoons have been found. Indeed, in one case the rise of temperature was more remarkable than even that during the celebrated Manila storm of 1882. This occurred on September 16, 1912, at Taito, Formosa. Between 8 and 9 p. m. of the 16th, the minimum reading

[1] *Sidney M. Ballou*, "The Eye of the Storm." American Meteorological Journal 1892, 9:67–82, 121–127.
[2] *Algué*, "Cyclones of the Far East," p. 63.
[3] "Lehrbuch der Meteorologie," Leipzig, 1915, p. 596.

of the barometer was 712.4 mm. (28.05 in.) and coinciding with this minimum, there was a rise of 10.5C. (19.°F.), from 24.1°C. (75.4°F.) to 34.6° C. (94.1°F.) in temperature, as recorded by the thermograph during the short interval of one hour. From 10 p. m. to midnight the temperature fell about 8° C. (14.4°F.).[4] A copy is here reproduced from the monthly Bulletin of the Philippine Weather Bureau of the barograph and thermograph curves which were furnished to the Manila Observatory by the director of Taihoku Observatory, Formosa. This typhoon originated at lat. 16° N.; long. 138° E. on September 10, 1912. It crossed the Island of Formosa on the night of the 16th, and landed on the Chinese coast, south of Foochow, on the morning of the 17th. Aside from the remarkable increase of temperature during the passage of the eye of this storm, it will be remembered as one of the most notable typhoons in the annals of the cyclones of the Far East. The wind velocities recorded at Taito and Tainan, both in Formosa, were the highest since the establishment of the meteorological stations there, in January, 1901, and January, 1897, respectively. As the result of the storm, 107 persons were killed, 293 injured, 91,400 houses were utterly demolished, and 115,700 houses partly destroyed. The English steamer *Dacre Castle* and the Japanese steamer *Hanyestsu Maru* were both wrecked.

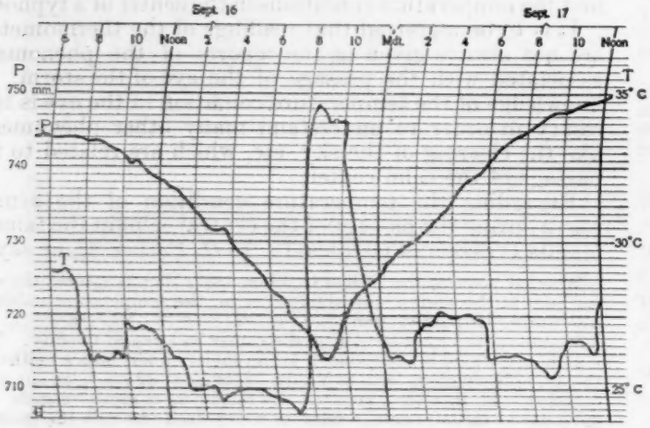

FIG. 1.—Barograph and thermograph curves at Taito, Formosa, September 16–17, 1912.

Other details with regard to the passage of the calm, the diameter of the calm area, the clearing of the sky, etc., at Taito are not given, either in the Philippine reports or in the Japanese Meteorological Journal. Whether the relative humidity decreased during the time that the temperature was rising is not known, but it probably did. In examining the thermograph curve of Taito, attention should be directed to the fact that the increase of temperature took place at 8–9 p. m., and not at midday, as was the case in the Manila typhoon of 1882. Therefore, Father Algué's objection to the theory of descending air currents in the central calm area, as quoted above, does not hold in this case. For even granting that the sky cleared at Taito between 8 and 9 p. m. of the 16th, no possible radiation could have been received at the place to increase the temperature in the eye of the storm to the extent of 10° C. Indeed, a clear sky in this case would have just the opposite effect, as it would accelerate nocturnal radiation and hence decrease the atmospheric temperature. As will be seen later, this is not the only case where the increase of temperature in the eye of the storm happened to come in the late evening or early morning hours. Unless, therefore, a more satisfactory hypothesis than that of Father Algué's can be offered to explain such cases, we shall be obliged to accept the theory of descending currents in the eye as the most plausible solution of the problem.

Another case of increase of temperature in the central calm occurred in the typhoon of July 12–16, 1909. Mr. A. Beljonne, assistant meteorologist at Phulien Observatory, Indo-China, in describing this storm states:[5]

> At 3:30 a. m. (16th) the wind inclines toward north by west, and then veers successively to north by east and northeast; violent squalls continue until about 4:20 a. m. * * * During this interval, disturbed by some wind squalls, the rain was reduced to a few drops and there passed several minutes of relative calm. At the time of the passage of the vortex (pressure 725.3 mm. or 28.55″), a rather unusual phenomenon manifests itself, to wit, an increase of temperature. From 3:04 to 4:09 a. m. the thermometer rose from 22.7° C. (72.9° F.) to 25° C. (77° F.), thus confirming in part the hypothesis of a local and exceptional descending movement of the air of higher strata.

Mr. Beljonne added in a footnote to the above report:

> The rise of temperature has been observed likewise at Haiphong, as is attested by the thermograph of this station, which between 3 and 4 a. m. rose from 24.9° C. (76.8° F.) to 26.4° C. (79.5° F.). During the passage of the center the clouds must have been merely reduced to a thin covering. In fact, we have not noticed any clearing of the sky such as by common consent is called the "eye of the storm;" not a single star has been visible at Phulien during that time. Although there was a rise in temperature, this failed to produce a corresponding diminution of the relative humidity, the hygrograph of the observatory continued to register the degree of saturation.

The third case happened during the typhoon of Cagayan de Luzon, October 9–14, 1908, which produced a flood in Luzon the like of which was unknown in that region. The increase of temperature was recorded at Aparri in the afternoon of October 13 during the passage of the relative calm. We quote here the report given by M. Manuel Delago, observer at Aparri.[6]

> From 4 a. m. of the 13th the gusts from NNW. had a velocity of more than 50 miles per hour and the barometric fall was extremely alarming. * * * At 10:45 a. m. the barometer read 716.29 mm. (the minimum) and then began to rise rapidly, with winds from the NNE. to E. and sky overcast; from 12 to 2 p. m. there was a kind of relative calm alternating with gusts from the E. and SE., during which the rain slackened. A little after 2 p. m. the wind freshened again from the SE., with clear sky in the southeastern and southwestern quadrants; the rain ceased and the wind was hot and dry; I could not observe the temperature, as the thermometers were destroyed. The thermometer attached to the barometer rose from 25° to 27° C., although it was not exposed to the air.

The last case occurred in the typhoon of May 24–28, 1906, which, according to the Manila report, was one of the most violent storms of the month of May. The increase of temperature in the central calm was registered on board the steamship *Fathomer*, anchored in Lamit Bay, Ambos Camarines, Philippine Islands. The following account is taken from the log of the *Fathomer* as published in the Monthly Bulletin of the Philippine Weather Bureau:[7]

> May 26: The vortex came about 1:15 (a. m.), without any shifting of the wind; the abatement of the wind was gradual, the zone of relative calm lasting about 5 minutes. By this time the force of the wind was less than 1 from N. From this time until 2:20 the force was less than 1, veering gradually through the W. to SE. At times the calm was so perfect as to produce hardly any deflection in tobacco smoke. Some slight rain fell during the passage of the center. The sky did not clear, but broke and lightened visibly to the eastward.
> * * * Systematic thermometric readings were not taken during the passage of the storm, but just before the advent of the center the thermometer read between 82° and 83° F. At the center this rose to between 85° and 86° F., and after the center passed fell again, reaching a somewhat lower temperature than before, being about 77° to 78° F.

[4] Monthly Bulletin of the Philippine Weather Bureau, September, 1912, pp. 263–265.

[5] Monthly Bulletin of the Philippine Weather Bureau, July, 1909, p. 220.
[6] Monthly Bulletin of the Philippine Weather Bureau, October, 1908, p. 371.
[7] May, 1906, p. 120.

This latter may have been partly due to the natural temperature change, as the temperature would reach a minimum just before daylight.

It is to be noted that no systematic thermometer readings were made during the passage of the calm center from 1:10 a. m. to 2:20 a. m.[8] Hence, the reading of 86° F. (30° C.) may not have been the highest temperature which was reached during that interval. Granting that it was, the increasing of temperature from 1 a. m. to the maximum temperature (between 1:10 a. m. and 2:20 a. m.) was 1.7° C. (3° F.) and the decrease of temperature from that time to 3 a. m. was 4.4° C. (8° F.).

So far as the writer has been able to determine, no other occurrence of an increase of temperature in the eye of a typhoon was recorded on board a steamship at sea during the years 1904–1915. One case was, however, mentioned by Father Algue in "The Cyclones of the Far East." In discussing the hurricane wave, Father Algue referred to the typhoon of August 16 to 18, 1879.[9] The report on this storm is so interesting that the following statements are here included:

The wind continued to stiffen, blowing a hard northeast gale at 4 p. m. (17th). * * * The barometer, falling continually, registered at this hour 746.75 mm., while the thermometer showed 31.1° C., the heat making itself felt intensely. The covering of clouds very dense, low, and threatening; thick, fine rain; the outlook exceedingly limited owing to the darkness. Between 4 and 5 o'clock the wind increased, and finally blew with inconceivable fury. * * * During this hour the barometer fell from 746.75 mm. to 723.89 mm., at 5 o'clock, while the thermometer rose to 32.2°. * * *

At 10 minutes past 5 a sudden calm fell upon us, the barometer showing 721.35 mm., the thermometer 33.3° C. On penetrating into the vertex the furious east-northeast wind had suddenly left us. For two or three minutes we still heard its howling, then reigned silence all around us.

There, within this terrible circle, the waves, seething, towering, of immense bulk, broke over us from every side, each one placing the ship in immediate peril. * * * The gray sky grew lighter here and there, and now and then the sun broke through for a moment as if to illuminate the scene of horror.

According to the above account there was a rise of 1.1° C. (2° F.) in temperature within the short space of 10 minutes just before entering the zone of absolute calm. The increase of temperature in this case may have been due to solar radiation. But since the rise of the thermometer preceded, or at least was simultaneous with, the partial clearing of the sky, it is more likely that both were the effect of the same cause—viz, a gentle descending current.

[8] Loc. cit., p. 121. [9] *Algue:* "The Cyclones of the Far East," p. 172.

SECTION III.—FORECASTS.

FORECASTS AND WARNINGS, SEPTEMBER, 1918.

By H. C. FRANKENFIELD, SUPERVISING FORECASTER.

[Dated: Washington, Oct. 7, 1918.]

GENERAL PRESSURE DISTRIBUTION OVER THE NORTHERN HEMISPHERE EXCEPT EUROPE AND INTERIOR ASIA.

Pressure over the southern portion of the North Pacific Ocean, as indicated by the observations at Honolulu, T. H., was nearly normal throughout the month, with a slight tendency toward subnormal conditions. Observations at Midway Island showed a somewhat more decided action, with moderately high pressure during the first and third decades of the month, except on the 29th and 30th, and with two well-defined depressions during the second decade. Over the North Pacific Ocean conditions were much more active and over a much wider field, embracing the whole of the northeastern Pacific Ocean and Alaska. Over this large area high pressure, not of exceptional character, prevailed during the greater portion of the first half of the month, with a single interruption on the 9th and 10th, while during the second half of the month, except during the last three days, low pressure ruled, with a great depression on the 17th and 18th (a few days earlier over the Aleutian Islands). However, conditions over extreme southern Alaska were not quite so pronounced as to the northward.

Ordinarily some of these decided pressure fluctuations over the North Pacific Ocean extend southeastward over the United States, in a somewhat lesser degree of course; but during this month there was a remarkable failure of such movement, and entire absence of strong cyclonic action throughout the United States proper, although there was a depression of considerable strength over the lower St. Lawrence Valley from the 27th to the 29th, inclusive. This depression, however, was a more or less composite one, the resultant, first, of a moderate cyclone from northwestern Ontario and a secondary one that developed off the Middle Atlantic coast during the 26th, and second. of a marked cyclone that moved in an east-southeast direction from the region north of latitude 55°. This second cyclone may have been the eastward manifestation of the one that prevailed over the Aleutian Islands and northern Alaska from the 21st to the 23d, inclusive, although it passed out of eastern Alaska with much diminished intensity. Its center was apparently some distance north of Alberta on the morning of the 25th, and by the morning of the 27th it had reached the southwestern portion of Hudson Bay, Port Nelson at that time reporting a barometer reading of 29.34 inches.

As a whole, pressure distribution was somewhat above normal over the United States during the month, except in the Atlantic States and along the Gulf of Mexico, where it ruled rather low, the conditions over the former district having been due mainly to a series of moderate secondary depressions of irregular definition and movement. Exceptions should be noted as follows: Over the Southwest and the Central West, moderately low pressure prevailed during the second decade of the month, and during the last few days. The low pressure over Florida and the east Gulf of Mexico was the result of a tropical disturbance that did not progress north of Florida.

Over the central portion of the North Atlantic Ocean moderately high pressure prevailed throughout the month, except from the 4th to the 6th, inclusive, when it was low on account of a tropical disturbance that apparently passed northeastward a short distance west of the island of Bermuda during the day and night of the 4th, with a barometer reading at Hamilton, Bermuda, of 28.88 inches at 8 p. m. of the 4th. There were no evidences of this storm near the Atlantic coast other than an unusually high sea swell at Nantucket on the 5th and 6th, reaching its crest at 10 a. m. of the 6th.

Over the southern portion of the Atlantic Ocean pressure did not vary much from normal conditions.

Over the Caribbean Sea pressure was low during the first half of the month and nearly normal thereafter, except during the early days of the last week, when a disturbance was noted over the extreme western portion of the sea. It apparently recurved to the north-northeastward over eastern Yucatan and was finally lost over the northern portion of the Florida Peninsula. So far as reported, this storm was not severe except over portions of Pinellas County, Fla., and that portion of the Gulf of Mexico immediately adjacent, where several casualties were reported to have occurred.

Previous to this another disturbance of very moderate character, so far as is known, moved northwestward across the eastern Caribbean. It first came under observation at the island of Barbados on the evening of the 8th, apparently moved northwestward across the Caribbean, crossing Haiti during the 12th, inclined to a more northerly direction, and was last distinguished near Great Abaco Island on the morning of the 14th. This storm evidently dissipated between Bermuda and the south Atlantic coast, where pressure fell somewhat on the 14th.

Reports from Lisbon and the Azores Islands were resumed on September 1, 1918, and the latter showed moderately low pressure from the 1st to the 5th and the 13th to the 18th, all inclusive, and sustained and fairly well-marked high pressure thereafter.

STORM WARNINGS.

As a natural sequence of the absence of marked cyclonic disturbances, storm warnings during the month of September were neither numerous nor of wide application. Quite a number of warnings for moderate storms were displayed over limited areas on the Lakes and along the Atlantic Coast, and there were also a few local high winds of limited duration for which no warnings were ordered. The warnings displayed were justified either as a whole or in part, except in a few instances. The most marked failure attended the display of northeast warnings on the 28th from Georgia to Fort Monroe, Va. These were ordered on the assumption that the tropical disturbance, then over northern Florida, would continue northeastward with a probable increase in intensity. However, the storm dissipated over Florida and there were no strong winds on the Atlantic coast.

Advices regarding the three tropical disturbances of the month were issued, as usual, at frequent intervals to all interested parties.

FROST WARNINGS.

Frost warnings were issued on 21 days of the month, beginning with the 4th in upper Michigan. As a whole, extensive areas were not covered at any one time. Antecedent conditions were frequently more or less uncertain, and the subsequent occurrences were somewhat unsatisfactory at times from a forecasting viewpoint. Quite often the occurrence of frost was contingent upon clearing conditions that did not materialize as rapidly as had been expected, and in a few instances the clearing conditions approached more rapidly than had been anticipated, with resulting frosts that had not been forecast. However, there were no failures to forecast any extensive frost occurrences.

Chicago, Ill., Forecast District.—September was abnormally cool in nearly all parts of this forecast district and frosts were of frequent occurreance. Warnings were issued on 20 days during the month, although for limited areas in some instances. By the end of the second decade of the month killing frost or freezing temperature had occurred as far south as extreme northern Kansas and extreme northwestern Missouri and as far east as central Iowa and central Wisconsin. However, none had occurred in portions of Montana and Wyoming. The southern and eastern limits of killing frost by September 24 in an average year include only the territory north of the central portions of Wisconsin and Minnesota, northwestern Nebraska, and western and extreme northern South Dakota. The most important warnings were those issued on the 19th, 20th, and 26th. Most of the warnings were verified, although cloudiness prevented the formation of frost in some sections, especially in the upper Mississippi Valley and western Lake region during the night of the 19th–20th.

Warnings were sent to the cranberry bogs of Wisconsin on 16 days and no frost occurred without warning, except a light frost at Berlin on the 12th. There were two warnings which failed of verification on account of persistent cloudiness. The crop was nearly all harvested by October 1 with fair to good yields, and the entire failure of the crop was prevented only by flooding the bogs whenever heavy frost or freezing temperature was predicted.

On account of the unusually favorable weather conditions during the summer months tobacco matured much earlier than last year in the Wisconsin fields, and one-half to three-fourths of the crop was harvested by September 10 and nearly all by the 17th. No frost warnings were required in the Madison region and none was sent until the 19th. Warnings of frost were sent to the tobacco fields of western Wisconsin on the 9th and 15th. Heavy frost was predicted for the Chippewa Falls region for the night of the 9th–10th and the warning was fully verified, freezing temperature and killing frost occurring. The following reference to the warning was made in the University of Wisconsin Press Bulletin of the 26th:

TIMELY FROST WARNING SAVES TOBACCO CROP.

Tobacco growers in Chippewa County took advantage of the frost warnings sent out by the Weather Bureau early in the month and thereby saved their tobacco crops from damage.

All farmers with telephones were notified of the frost warning through the Weather Bureau at Chippewa Falls. They cut their tobacco and piled it, so that it would be damaged only slightly. The next day, reports the weather observer, the piles were trimmed out and the tobacco allowed to wilt. In low places the piles had been covered with straw. As a result of the warning the tobacco is curing well.

Special forecasts for the benefit of the Free State Fair held at Topeka, Kans., were issued on the 9th and 11th. In regard to these forecasts, the official in charge at Topeka writes as follows:

I wish to thank you for your kindness in extending the daily forecasts this week for the benefit of the Free State Fair held at this place. This year this was probably the largest gathering of the nature ever occurring in Kansas, and the fact that it was possible to promise fair weather for several days in advance had no little part in contributing to its success. The special forecast of the 11th reading "Fair weather with seasonable temperatures next two or three days" was especially welcome, as its unequivocal promise made it possible for the fair management to plan events without fear of having them spoiled by unfavorable weather conditions, and it also encouraged persons living at a considerable distance to motor in to the event.—*Chas. L. Mitchell.*

New Orleans, La., Forecast District.—The weather during the month was free from storms and no storm warnings were issued.

Frost was forecast on the 16th, 20th, 26th, 27th, and 28th, for areas in the northern portion of the district. These warnings were mostly for light frost, or frost in low places, and were but partially justified. No severe or extensive frost damage occurred.

For the benefit of persons engaged in harvesting or other outdoor work, the forecast of fair weather, issued on the 7th, was extended 24 to 48 hours beyond the usual period and was fully verified.—*R. A. Dyke.*

Denver, Colo., Forecast District.—Weather conditions during September reflected the persistency of low-pressure areas in the district and the movement southward along the eastern slope of the majority of the high-pressure areas. Unsettled weather prevailed almost the entire month with frequent rains during the first half. While sharp changes in temperature were more common than usual and several decidedly cool spells occurred, practically no damage from frost occurred. The warnings were issued for the most part for local frost on the eastern slope based on the expected southward movement of high-pressure areas; on the 23d, 24th and 25th the warnings included areas west of the Continental Divide.—*Frederick H. Brandenburg.*

San Francisco, Cal., Forecast District.—Much unsettled weather prevailed in this district during September, especially in the Plateau region and California, where frequent, and in many places very heavy, rains occurred. In the western portions of both Washington and Oregon the precipitation was unusually light. In the Plateau region there were four distinct rainy periods—8th and 9th, 12th to 14th, 22d and 23d; and 29th to the end of the month, inclusive; and in California there were three rainy periods—11th to 14th, 21st and 22d, and from the 27th to the end of the month.

In portions of the Sacramento, the lower San Joaquin, Santa Clara, and Salinas valleys, and in the central section of the Sierra Nevada mountains and foothills the monthly amounts of rainfall exceeded all previous records for September, and the daily amounts at many stations were excessive. On the extreme northern California coast the rainfall was but slightly above the normal, but in most other sections of the State the amounts varied from 3 to over 20 times the usual monthly amount.

The rains came at the height of the prune and raisin-drying and tomato-canning season, and bean and walnut harvest; and in those sections where the rainfall was heavy, and preceded and followed by protracted damp

and cloudy weather, protection was impossible and great injury resulted. Fortunately, in the Fresno district there was but light rain, although much cloudiness, and most of the Thompson seedless raisins were uninjured; but the Muscats are still on the trays, and depend upon future weather. In the Orange County bean district the crop was practically secured before the rain came.

Ample warnings were issued in all instances and all warnings were justified and appreciated by the fruit growers.

There were numerous thunderstorms in California, which is unusual in September, and much damage was done by lightning to electric plants, oil wells, and some buildings.

Fire weather warnings were issued in Washington, Oregon, and Idaho, on the 11th and the 27th. Those on the 11th read "Dry northeast winds and continued high temperatures to-day, to-night, and Thursday;" and on the 27th, "Moderate hot, dry north to northeast winds favorable for forest fires to-day, Saturday, and probably Sunday." These were timely, and regarding the latter the Oregon Forest Fire Association stated: "You will be interested to know that this forecast comes at what is considered a somewhat critical juncture, as we have fires scattered over practically the whole of northwestern Oregon, and definite knowledge that the present hot weather is going to continue will very materially affect our plans."

No storm warnings were issued and none were needed.

—G. H. Willson.

SECTION IV.—RIVERS AND FLOODS.

RIVERS AND FLOODS, SEPTEMBER, 1918.

By ALFRED J. HENRY, Meteorologist in Charge.

Dated: River and Flood Division, Washington, D. C., Oct. 30, 1918.]

Rains during September were generally light. The only stream in the United States in which a flood occurred was the Bourbeuse River in Missouri. At Union, Mo., a stage of 11.2 feet occurred on September 6. Flood stage is at 10 feet. No drainage was reported.

MEAN LAKE LEVELS DURING SEPTEMBER, 1918.

By UNITED STATES LAKE SURVEY.

[Dated: Detroit, Mich., Oct. 3, 1918.]

The following data are reported in the "Notice to Mariners" of the above date:

Data.	Lakes.[1]			
	Superior.	Michigan and Huron.	Erie.	Ontario.
Mean level during September, 1918:	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Above mean sea level at New York	602.54	581.50	572.47	246.20
Above or below—				
Mean stage of August, 1918	+0.12	−0.29	−0.13	−0.23
Mean stage of September, 1917	−0.18	−0.15	−0.80	−0.73
Average stage for September, last 10 years	−0.11	+0.86	+0.08	−0.03
Highest recorded September stage	−1.54	−1.93	−1.47	−1.41
Lowest recorded September stage	+1.05	+1.84	+1.19	+2.20
Average relation of the September level to—				
August level	.....	−0.2	−0.3	−0.4
October level	.....	+0.2	+0.3	+0.4

[1] Lake St. Clair's level: In September, 575.77 feet.

SECTION V.—SEISMOLOGY.

SEISMOLOGICAL REPORTS FOR SEPTEMBER, 1918.

W. J. HUMPHREYS, Professor in Charge.

[Dated: Weather Bureau, Washington, D. C., Nov. 1, 1918.]

TABLE 1.—*Noninstrumental earthquake reports, September, 1918.*

Day.	Approximate time, Greenwich Civil.	Station.	Approximate latitude.	Approximate longitude.	Intensity Rossi-Forel.	Number of shocks.	Duration.	Sounds.	Remarks.	Observer.
		CALIFORNIA.								
1918.	*H. m.*		° ′	° ′			*M. s.*			
Sept. 7	9 56	Calexico	32 41	115 30	4	1	15	None	Bump and rapid trembling N-S.	H. M. Rouse.
	10 02	.....do	32 41	115 30	4	1	20	None	.....do	Do.
	10 24	.....do	32 41	115 30	3	1	03	None	Rapid trembling E-W	Do.
		OKLAHOMA.								
10	15 45?	El Reno	35 31	97 57	.....	1	03	.....	.....	M. B. Cope.
	15 30?	Union City	35 23	97 57	.....	1	01	.....	Abrupt bump	James E. Robbins.
	20 00?	Fort Reno	35 33	98 02	3	1	Few	Rumbling	Like rocks falling from roof of building. Abrupt trembling.	Corpl. O. A. Gassaway
11	5 40?	El Reno	35 31	97 57	5–7	1	05	.....	Abrupt bump SW–NE. Some plaster fell. Clock stopped.	M. B. Cope and J. R. Randolph.
	5 20?	Fort Reno	35 33	98 02	5	1	Few	Rumbling	Abrupt trembling	Corpl. O. A. Gassaway.
	5 30?	Union City	35 23	97 57	5	1	01	Rumbling	Abrupt bump; some dishes and fruit jars broke.	James E. Robbins.
	5 45?	Yukon	35 30	97 44	5	1	03	Faint	Rumbling from west like distant freight train, ending with abrupt thud and trembling W-E.	Gordon McComas.
	8 00?	El Reno	35 31	97 57	Light	1	01	.....	.....	M. B. Cope.
	8 30?	Union City	35 23	97 57	.....	1	01	.....	.....	James E. Robbins.

TABLE 2.—*Instrumental seismological reports, September, 1918.*

(Time used: Mean Greenwich, midnight to midnight. Nomenclature: International.)

[For significance of symbols see REVIEW for January, 1918, p. 34.]

Alaska. *Sitka. Magnetic Observatory.* U. S. Coast and Geodetic Survey. J. W. Green.

Lat., 57° 03′ 00″ N.; long., 135° 30′ 06″ W. Elevation, 15.2 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants.. {E V 10, T_0 17; N V 10, T_0 15}

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
			H. m. s.	*Sec.*	μ	μ	*km.*	
1918. Sept. 7	.....	eP_E	17 24 33	5	.....	.....	.....	
		eP_N	17 24 40	6	.....	.....	.....	
		S_N	17 31 19	16	.....	.....	.....	
		S_E	17 31 20	14	.....	.....	.....	
		L_E	17 38 17	25	.....	.....	.....	
		M_E	17 48 16	17	3,250	.....	.....	
		M_N	17 46 42	18	.....	1,110	.....	
		C	17 50 ..	17	.....	.....	.....	
		F_N	20 23 ..	11	.....	.....	.....	
		F_E	20 41 ..	11	.....	.....	.....	
12	.....	eP_N	18 06 24	.....	.....	.....	.....	
		eP_E	18 06.30	.....	.....	.....	.....	
		eL_E	18 08 04	.....	.....	.....	.....	
		L_N	18 08 06	15	.....	.....	.....	
		M_E	18 09 45	9	10	.....	.....	
		M_N	18 09 54	10	.....	20	.....	
		F	18 19 ..	8	.....	.....	.....	

Arizona. *Tucson. Magnetic Observatory.* U. S. Coast and Geodetic Survey. F. P. Ulrich.

Lat. 32° 14′ 48″ N.; long., 110° 50′ 06″ W. Elevation, 769.6 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants.. {E V 10, T_0 14; N V 10, T_0 19}

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
			H. m. s.	*Sec.*	μ	μ	*km.*	
1918. Sept. 4	.....	P_E	19 56 01	4	.....	.....	.....	Records for this month not very good, some lost motion in the stylus being indicated.
		P_N	19 56 13	.....	.....	.....	.....	
		eL_E	19 56 49	.....	.....	.....	.....	
		eL_N	19 57 09	.....	.....	.....	.....	
		M	19 57 46	6	10	5	.....	
		C	19 58 26	6	.....	.....	.....	
		F	19 59 ..	.....	.....	.....	.....	
7	.....	P_N	17 28 10	.....	.....	.....	.....	
		P_E	17 28 12	.....	.....	.....	.....	
		S_E	17 37 12	.....	.....	.....	.....	
		SN	17 37 16	.....	.....	.....	.....	
		eL_E	17 51 ..	22	.....	.....	.....	
		eL_N	17 52 ..	20	.....	.....	.....	
		M_N	18 06 04	17	.....	120	.....	
		M_E	18 11 57	17	850	.....	.....	
		C	18 23 ..	16	.....	.....	.....	
		F	20 30 ..	15	.....	.....	.....	
11	.....	eP	3 48 31	.....	.....	.....	.....	
		eL	3 49 20	.....	.....	.....	.....	
		M_N	3 49 55	.....	.....	40	.....	
		M_E	3 50 41	.....	30	.....	.....	
		C	3 51 ..	.....	.....	.....	.....	
		F_E	3 53 ..	.....	.....	.....	.....	
		F_N	3 58 ..	.....	.....	.....	.....	

California. *Berkeley. University of California.*

Lat., 37° 52′ 16″ N.; long., 122° 15′ 37″ W. Elevation, 85.4 meters.

(See Bulletin of the Seismographic Stations, University of California.)

California. *Mount Hamilton. Lick Observatory.*

Lat., 37° 20′ 24″ N.; long., 121° 38′ 34″ W. Elevation, 1,281.7 meters.

(See Bulletin of the Seismographic Stations, University of California.)

California. *Point Loma. Raja Yoga College.* F. J. Dick.

Lat., 32° 43′ 03″ N.; long., 117° 15′ 10″ W. Elevation, 91.4 meters.
Instrument: Two-component, C. D. West seismoscope.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
			H. m. s.	*Sec.*	μ	μ	*km.*	
1918. Sept. 5	.....	.....	.....	.....	100	100	.....	Tremors during 24 hours preceding 15h. 00m. on dates given.
8	.....	.....	.....	.....	100	200	.....	
12	.....	.....	.....	.....	200	200	.....	
13	.....	.....	.....	.....	100	200	.....	
14	.....	.....	.....	.....	100	200	.....	
17	.....	.....	.....	.....	50	100	.....	
19	.....	.....	.....	.....	50	50	.....	
21	.....	.....	.....	.....	50	100	.....	

California. *Santa Clara. University of Santa Clara.* J. S. Ricard, S. J.

Lat., 37° 26′ 36″ N.; long., 121° 57′ 63″ W. Elevation, 27.43 meters.

(See Record of the Seismographic Station, University of Santa Clara.)

Colorado. *Denver. Sacred Heart College.* Earthquake Station. A. W. Forstall, S. J.

Lat., 39° 40′ 36″ N.; long., 104° 56′ 54″ W. Elevation, 1,655 meters.

Instrument: Wiechert 80 kg., astatic, horizontal pendulum.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
			H. m. s.	*Sec.*	μ	μ	*km.*	
1918. Sept. 7	.....	P_E	17 37 ..	.....	.....	.....	.....	Time of S very doubtful.
		P_N	17 38 ..	.....	.....	.....	.....	
		S	17 48 (?)	.....	.....	.....	.....	
		L_N	17 52 ..	15	*2,000–3,000	.....	.....	
		L_E	17 54 ..	15	*2,000–3,000	.....	.....	
		M	18 05 ..	15	*2,000	*3,000	.....	
		C	18 37 ..	.....	.....	.....	.....	
		F	19 28 ..	.....	.....	.....	.....	
14	.....	.....	.....	.....	.....	.....	.....	Wavelets at intervals during day.
17	.....	L	5	.....	.....	.....	.....	Visible activity on both components.
		F	8	.....	.....	.....	.....	
28	.....	L_N	4 10 ..	.....	.....	.....	.....	Distinct but very small and irregular.
		F_N	4 17 ..	.....	.....	.....	.....	

* Trace amplitude.

District of Columbia. *Washington. U. S. Weather Bureau.*

Lat., 38° 54′ 12″ N.; long., 77° 03′ 03″ W. Elevation, 21 meters.

Instrument: Marvin (vertical pendulum), undamped. Mechanical registration.

Instrumental constants.. V 110, T_0 6.4

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
			H. m. s.	*Sec.*	μ	μ	*km.*	
1918. Sept. 7	.....	eP	17 28 48	.....	.....	.....	.....	Long continued L waves of nearly uniform amplitude.
		eS	17 39 22	.....	.....	.....	.....	
		eL	17 49 ..	.....	.....	.....	.....	
		L	18 03 04	.....	.....	.....	.....	
		F	22	.....	.....	.....	.....	
11	.....	e	4 03 40	.....	.....	.....	.....	F lost in microseisms.
		F	4 15 ..	.....	.....	.....	.....	
12	.....	e	18 24 ..	.....	.....	.....	.....	
		L	18 29 10	.....	.....	.....	.....	
		F	18 50 ..	.....	.....	.....	.....	
14	.....	P	17 17 36	.....	.....	.....	9,080	Trace of small amplitude throughout.
		S	17 27 56	.....	.....	.....	.....	
		L	17 51 ..	20	.....	.....	.....	
		F	18 35 ..	.....	.....	.....	.....	
22	.....	e	10 14 20	.....	.....	.....	.....	Do.
		S?	10 17 30	.....	.....	.....	.....	
		eL	11 15 ..	.....	.....	.....	.....	
		F	11 30 ..	.....	.....	.....	.....	

TABLE 2.—*Instrumental seismological reports, September, 1918*—Continued.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
District of Columbia. *Washington. U. S. Weather Bureau*—Contd.								
1918.			*H. m. s.*	*Sec.*	*μ*	*μ*	*km.*	
Sept. 29	.....	e?	12 19 ..	.....	.....	.....	.....	e lost in microseisms. Amplitudes small; do not show on E–W.
		S	12 19 55	.....	.....	.....	.....	
		eL	12 47 ..	.....	.....	.....	.....	
		F	13 10 ..	.....	.....	.....	.....	
30	.....	P	13 44 45	.....	.....	.....	7,075	
		S	13 53 23	.....	.....	.....	.....	
		L	14 10 ..	.....	.....	.....	.....	
		L	14 15 ..	16	.....	.....	.....	
		F	14 50 ..	.....	.....	.....	.....	
30	.....	eL?	18 45 ..	.....	.....	.....	.....	Trace amplitudes small throughout.
		L	19 00 ..	20	.....	.....	.....	
		L	19 36 ..	16	.....	.....	.....	
		F	20 15 ..	.....	.....	.....	.....	

District of Columbia. *Washington. Georgetown University.* F. A. Tondorf, S. J.

Lat., 38° 54′ 25″ N.; long., 77° 04′ 24″ W. Elevation, 42.4 meters. Subsoil: Decayed diorite.

Instruments: Wiechert 200 kg. astatic horizontal pendulums, 80 kg. vertical.

Instrumental constants.		V	T_0	ε
	E	165	5.4	0
	N	143	5.2	0
	Z	80	5.0	0

1918.			*H. m. s.*	*Sec.*	*μ*	*μ*	*km.*	
Sept. 4	.....	e_E	20 10 06	.....	.....	.....	.....	Heavy microseisms.
		e_N	20 10 11	.....	.....	.....	.....	
7	.....	eP	17 28 53	.....	.....	.....	.....	Do.
		eS_N	17 39 26	.....	.....	.....	.....	
		iS_E	17 39 29	.....	.....	.....	.....	
		eL?	17 49 48	14	.....	.....	.....	
		M_{E1}	18 07 57	20	*3,400	.....	.....	
		M_{N1}	18 13 05	17	.....	*2,800	.....	
		M_{E2}	18 18 37	17	*2,600	.....	.....	
		M_{N2}	18 19 10	15	.....	*2,000	.....	
		F	22 30 ..	.....	.....	.....	.....	
11	.....	e_N	4 03 40	.....	.....	.....	.....	Do.
		e_E	4 04 07	.....	.....	.....	.....	
		F	4 50 ..	.....	.....	.....	.....	
14	.....	eP	17 17 40	.....	.....	.....	.....	
		S	17 28 09	.....	.....	.....	.....	
		L_E	17 52 ..	19	.....	.....	.....	
		L_E	17 55 25	19	.....	.....	.....	
		F	19 15 ..	.....	.....	.....	.....	
29	.....	eP	12 18 59	.....	.....	.....	.....	Do.
		S_E	12 29 59	.....	.....	.....	.....	P possibly earlier. Sheet taken off at 12h. 36m.
		S_N	12 30 03	.....	.....	.....	.....	
		F	? ? ?	.....	.....	.....	.....	
30	.....	e?	14 07 43	.....	.....	.....	.....	Needle put down at 14h. 04m. Very heavy microseisms.
		L_E	14 11 37	17	.....	.....	.....	
		L_N	14 11 48	17	.....	.....	.....	
		F?	14 50 ..	.....	.....	.....	.....	
30	.....	L_E	18 56 40	21	.....	.....	.....	Very heavy microseisms. Does not show on N–S.
		F	20 12 ..	.....	.....	.....	.....	

* Trace amplitude.

Hawaii. *Honolulu. Magnetic Observatory.* U. S. Coast and Geodetic Survey. Frank Neumann.

Lat., 21° 19′ 12″ N.; long., 158° 03′ 48″ W. Elevation, 15.2 meters.

Instrument: Milne seismograph of the Seismological Committee of the British Association.

Instrumental constant..	T_0
	18.6

1918.			*H. m. s.*	*Sec.*	*μ.*	*μ.*	*km.*	
Sept. 2	.....	P	14 25 00	.....	.....	.....	.....	Beginning very faint.
		S	14 32 30	19	.....	.....	.....	
		L	14 41 00	20	.....	.....	.....	
		M	14 49 00	19	*500	.....	.....	
		C	14 55 ..	18	.....	.....	.....	
		F	15 29 ..	19	.....	.....	.....	
5	.....	eP	7 45 18	20	.....	.....	.....	Phases ill defined. First P tremors very irregular. Faint disturbance as early as 7h. 27 m.
		L	7 49 12	22	.....	.....	.....	
		M	7 58 06	18	*200	.....	.....	
		C	8 06 12	19	.....	.....	.....	
		F	8 17 ..	19	.....	.....	.....	

* Trace amplitude.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
Hawaii. *Honolulu. Magnetic Observatory*—Continued.								
1918.			*H. m. s.*	*Sec.*	*μ*	*μ*	*km.*	
Sept. 7	.....	eL	7 51 ..	19	.....	.....	.....	Little more than a series of irregular tremors preceded by microseisms.
		M	8 00 48	.....	*100	.....	.....	
		C	8 02 48	.....	.....	.....	.....	
		F	8 14 ..	.....	.....	.....	.....	
7	.....	P	17 25 00	.....	.....	.....	.....	Pendulum swinging continuously off paper during time of M. Amplitude possibly 3 or 4 times this amount.
		S	17 32 00	.....	.....	.....	.....	
		L	17 36 54	18	.....	.....	.....	
		M	17 41 ..	.....	.....	.....	.....	
		to	17 50 ..	.....	*17,000	.....	.....	
		C	19 30 ..	17	.....	.....	.....	
		F	22 30 ..	18	.....	.....	.....	
8	.....	P	0 25 48	18	.....	.....	.....	
		S	0 32 24	20	.....	.....	.....	
		L	0 36 06	.....	.....	.....	.....	
		M	0 41 00	20	*1,100	.....	.....	
		C	0 45 ..	18	.....	.....	.....	
		F	1 30 ..	18	.....	.....	.....	
8	.....	eP	5 49 00	18	.....	.....	.....	
		S	5 55 42	18	.....	.....	.....	
		L	6 04 42	.....	.....	.....	.....	
		M	6 07 30	20	*300	.....	.....	
		C	6 12 ..	19	.....	.....	.....	
		F	7 07 ..	18	.....	.....	.....	
8	.....	eP	12 02 30	.....	.....	.....	.....	
		M	12 07 ..	.....	*100	.....	.....	
		C	12 10 ..	.....	.....	.....	.....	
		F	12 19 ..	.....	.....	.....	.....	
11	.....	eP	4 17 48	19	.....	.....	.....	Phases ill defined. Small disturbance at 6h. 28m. may be a separate quake, amplitude *100.
		S	4 27 48	18	.....	.....	.....	
		L	4 46 00	.....	.....	.....	.....	
		M	4 55 00	18	*300	.....	.....	
		C	5 07 ..	19	.....	.....	.....	
		F	7 16 ..	19	.....	.....	.....	
12	.....	P	13 31 30	17	.....	.....	.....	
		L	13 42 06	.....	.....	.....	.....	
		M	13 44 36	18	*200	.....	.....	
		C	13 50 00	19	.....	.....	.....	
		F	15 01 ..	19	.....	.....	.....	
12	.....	eP	18 15 42	.....	.....	.....	.....	F lost changing sheets.
		L	18 17 24	.....	.....	.....	.....	
		M	18 18 24	.....	*300	.....	.....	
		C	18 21 ..	.....	.....	.....	.....	
		F	.....	.....	.....	.....	.....	
14	.....	eP	17 13 36	18	.....	.....	.....	
		S	17 20 24	18	.....	.....	.....	
		L	17 30 54	.....	.....	.....	.....	
		M	17 34 36	18	*1,600	.....	.....	
		C	17 40 ..	18	.....	.....	.....	
		F	19 43 ..	18	.....	.....	.....	
15	.....	eP	18 18 00	.....	.....	.....	.....	
		L	18 31 30	.....	.....	.....	.....	
		M	18 38 00	.....	*200	.....	.....	
		C	18 42 ..	.....	.....	.....	.....	
		F	19 03 ..	.....	.....	.....	.....	
16	.....	eP	13 26 00	.....	.....	.....	.....	
		L	13 45 42	.....	.....	.....	.....	
		M	13 49 36	.....	*200	.....	.....	
		C	13 55 ..	.....	.....	.....	.....	
		F	14 38 ..	.....	.....	.....	.....	
22	.....	P	10 19 48	20	.....	.....	.....	Tremors of *100 and *200 amplitude occur at 13h. 30m. and 14h. 22m., respectively.
		L	10 54 00	.....	.....	.....	.....	
		M	11 03 48	19	*400	.....	.....	
		C	11 11 ..	18	.....	.....	.....	
		F	14 48 ..	18	.....	.....	.....	
25	.....	e	10 09 00	20	.....	.....	.....	Preceded by light tremors; e may be P or S.
		L	10 18 00	18	.....	.....	.....	
		M	10 23 00	.....	*200	.....	.....	
		F	11 48 ..	.....	.....	.....	.....	
28	.....	L	10 57 12	18	.....	.....	.....	Quake preceded and followed by light tremors.
		M	11 01 30	.....	*100	.....	.....	
		C	11 06 ..	.....	.....	.....	.....	
		F	11 18 ..	.....	.....	.....	.....	
30	.....	eP	13 42 12	18	.....	.....	.....	Record very irregular; evidently local.
		S	13 46 36	.....	.....	.....	.....	
		L	13 48 00	18	.....	.....	.....	
		M	13 49 00	18	*1,100	.....	.....	
		C	13 59 48	18	.....	.....	.....	
		F	15 28 ..	17	.....	.....	.....	
30	.....	P	16 24 18	.....	.....	.....	.....	Tremors continuous to following quake.
		L	16 34 42	18	.....	.....	.....	
		M	16 38 00	.....	*100	.....	.....	
		C	16 41 ..	.....	.....	.....	.....	
		F	.....	.....	.....	.....	.....	

* Trace amplitude.

TABLE 2.—*Instrumental seismological reports, September, 1918*—Continued.

Hawaii. *Honolulu. Magnetic Observatory*—Continued.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Sept. 30	.....	P.....	18 08 42	19	.....	.....	.....	Tremors continuous to follow quake.
		S.....	18 14 30	19	.....	.....	.....	
		L.....	18 19 06	.....	.....	.....	.....	
		M.....	18 25 30	18	*3,600	.....	.....	
		C.....	18 32 ..	18	.....	.....	.....	
		F.....	.....	17	.....	.....	.....	
30	.....	P.....	18 55 30	.....	.....	.....	.....	Possibly Srepl occurs at 19h. 03m. .06s.
		L.....	19 05 18	18	.....	.....	.....	
		M.....	19 10 00	19	*3,600	.....	.....	
		C.....	19 21 ..	19	.....	.....	.....	
		F.....	21 47 ..	19	.....	.....	.....	

* Trace amplitude.

Kansas. *Lawrence. University of Kansas.* Department of Physics and Astronomy. F. E. Kester.

Lat., 38° 57′ 30″ N.; long., 95° 14′ 58″ W. Elevation, 301.1 meters.

Instrument: Wiechert.

Instrumental constants.		T	T_0	e
	E	177	3.4	4:1
	N	205	3.4	4:1

Date.	Character.	Phase.	Time.	Period T.	Amplitude.	Amplitude.	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Sept. 7	.....	eP.....	12 28 06	.....	.....	.....	.....	Record very complex; many small waves throughout the record and their beginnings and endings very illegible.
		S_E?....	12 35 20	.....	.....	.....	.....	
		or	12 37 53	.....	.....	.....	.....	
		S_N.....	12 37 57	.....	.....	.....	.....	
		L_N.....	12 48 57	.....	.....	.....	.....	
		L_E?...	12 48 57	.....	.....	.....	.....	
		or	12 50 57	.....	.....	.....	.....	
		M_N.....	1 06 37	.....	.....	*12,400	.....	
		M_E.....	1 06 56	.....	*12,400	.....	.....	
		F_N.....	2 39 ..	.....	.....	.....	.....	
		F_E.....	2 53 ..	.....	.....	.....	.....	

* Trace amplitude.

Maryland. *Cheltenham. Magnetic Observatory.* U. S. Coast and Geodetic Survey. George Hartnell.

Lat., 38° 44′ 00″ N.; long., 76° 50′ 30″ W. Elevation, 71.6 meters.
Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants.		V	T_0
	E	10	15
	N	10	15

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Sept. 7	.....	P.....	17 29 23	3	.....	.....	.....	
		S_N.....	17 40 00	14	.....	.....	.....	
		S_E.....	17 40 11	14	.....	.....	.....	
		$eL_?$....	18 01 30	19	.....	.....	.....	
		M_E.....	18 24 31	15	1,200	.....	.....	
		M_N.....	18 29 02	15	.....	1,710	.....	
		C_N.....	18 36 ..	15	.....	.....	.....	
		C_E.....	18 53 ..	15	.....	.....	.....	
		F_E.....	20 35 ..	15	.....	.....	.....	
		F_N.....	21 40 ..	15	.....	.....	.....	
11	.....	P_N.....	4 03 58	3	.....	.....	.....	
		P_E.....	4 04 04	3	.....	.....	.....	
		M_N.....	4 08 ..	8	.....	5	.....	
		C_N.....	4 12 ..	.....	.....	.....	.....	
12	.....	eL_N....	18 29 48	.....	.....	.....	.....	
		eL_E....	18 30 08	.....	.....	.....	.....	
		M_N.....	18 30 25	13	.....	10	.....	
		M_E.....	18 30 55	11	10	.....	.....	
		F_E.....	18 34 ..	.....	.....	.....	.....	
		F_N.....	18 38 ..	.....	.....	.....	.....	
30	.....	e_N.....	14 12 25	.....	.....	.....	.....	
		L_N.....	14 14 57	.....	.....	.....	.....	
		M_N.....	14 15 57	15	.....	20	.....	
		F.....	14 23 ..	.....	.....	.....	.....	

Massachusetts. *Cambridge. Harvard University Seismographic Station,* J. B. Woodworth.

Lat., 42° 22′ 36″ N.; long., 71° 06′ 59″ W. Elevation, 5.4 meters. Foundation: Glacial sand over clay.

Instruments: Two Bosch-Omori 100 kg. horizontal pendulums (mechanical registration).

Instrumental constants.		V	T_0.	e
	E	80	23	0
	N	50	25	4:1

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Sept. 7	.....	*O*.....	*17 17 14*	.....	.....	.....	8,900	(80° 06′ of arc.) Special, subject to possible corrections. N record unsatisfactory. ePN masked by microseisms, comes later about 17h. 29m. 42s., and S_E about 17h. 40m. 22s., damped by magnet. East tylus off sheet from 18h. 12m. 36s. to 18h. 13m. 03s.
		iP_E....	17 29 22	7	.....	.....	.....	
		S_E.....	17 39 27	11	.....	.....	.....	
		M_E.....	17 40 21	20	6,500	.....	.....	
		eL_E?....	17 53 ..	.....	.....	.....	.....	
		M_E.....	18 04 ..	26	22,500	.....	.....	
		M_E.....	18 07 22	18	29,500	.....	.....	
		M_E.....	18 11 ..	16	35,750	.....	.....	
		M_E.....	18 12 36	14	65,000	.....	.....	
		M_E.....	18 15 27	15	49,750	.....	.....	
		M_E.....	18 21 ..	16	40,000	.....	.....	
		L_{repl}..	19 03 31	16	510	.....	.....	
		to	19 05 18	15	.....	.....	.....	
		L_{rep}?..	21 19 35	2–15	.....	.....	.....	
		F_E.....	22 05 ..	.....	.....	.....	.....	
8	.....	*O*?....	*0 28 04*	.....	.....	.....	6,485?	58° 25′ ? N component stopped.
		e_E?....	0	.....	.....	.....	.....	
		S_E.....	0 46 06	8	.....	.....	.....	
		eL_E....	0 56 32	28	.....	.....	.....	
		M_E?....	1 01 50	20	.....	.....	.....	
		C_E.....	1 07 14	15	.....	.....	.....	
		F.....	1 20 ..	.....	.....	.....	.....	
8	.....	eL_E....	6 26 38	28–24	.....	.....	.....	N component not working.
		L_E.....	6 31 58	20	.....	.....	.....	
		F.....	6 49 18	.....	.....	.....	.....	
11	.....	*O*.....	*4 postea*	.....	.....	.....	1,000–2,000	N undamped. E damped 1.5:1.
		e_N?....	4 04 28	.....	.....	.....	.....	
		e_E.....	4 05 59?	.....	.....	.....	.....	
		L_N?....	4 06 57	4–5	.....	.....	.....	
		L_E.....	4 07 01	12	.....	.....	.....	
		F.....	4 14 ..	.....	.....	.....	.....	
14	.....	*O*?....	17 05 ..	.....	.....	.....	10800?	N component not registering.
		e_E?....	17 39 24	6	.....	.....	.....	
		S_E.....	17 39 24	6	.....	.....	.....	
		eL_E....	17 51 32	20–30	.....	.....	.....	
		L_E.....	17 54 42	20	.....	.....	.....	
		L_E.....	17 58 52	15	.....	.....	.....	
		L_E.....	18 04 52	15	.....	.....	.....	
		L_E.....	18 09 46	15	.....	.....	.....	
		F?.....	18 25 ..	.....	.....	.....	.....	
30	.....	*O*?....	13 20 44	.....	.....	.....	10155?	e in microseisms.
		e?.....	13 ? ?	.....	.....	.....	.....	
		S_N.....	13 44 58	9	.....	.....	.....	
		S_E.....	13 44 59	8	.....	.....	.....	
		eL_N....	14 05 18	40	.....	.....	.....	
		L_E.....	14 08 20	20	.....	.....	.....	
		L_E.....	14 08 59	20	.....	.....	.....	
		L_E.....	14 14 09	20	.....	.....	.....	
		C_E.....	14 16 23	15	.....	.....	.....	
		F_E?....	14 41 ..	.....	.....	.....	.....	
30	.....	*O*.....	*18 postea*	.....	.....	.....	.....	Very distant. N undamped.
		L_E.....	18 56 19	24	.....	.....	.....	
		L_E.....	19 02 54	20	.....	.....	.....	
		to	19 07 53	.....	.....	.....	.....	
		L_E.....	19 08 25	15	.....	.....	.....	
		to	19 10 29	.....	.....	.....	.....	
		L_N.....	19 30 40	.....	.....	.....	.....	
		M_N?....	19 36 30	18	.....	.....	.....	
		M_N.....	19 38 00	15	.....	.....	.....	
		M_N.....	19 47 ..	20	.....	.....	.....	
		L_E.....	19 49 05	20	.....	.....	.....	
		to	19 54 13	.....	.....	.....	.....	
		L_E.....	20 03 ..	15	.....	.....	.....	
		F_E.....	20 50 ..	.....	.....	.....	.....	
30	.....	*O*.....	*1 postea*	.....	.....	.....	.....	Not identified on N.
		e_E?....	1 39 15	6	.....	.....	.....	
		e_E.....	1 41 39	6	.....	.....	.....	
		L_E.....	1 44 41	20	.....	.....	.....	
		F.....	2 03 ..	.....	.....	.....	.....	

TABLE 2.—*Instrumental seismological reports, September, 1918*—Continued.

Missouri. *Saint Louis. St. Louis University.* Geophysical Observatory. J. B. Goesse, S. J.

Lat., 38° 38′ 15″ N.; long., 90° 13′ 58″ W. Elevation, 160.4 meters. Foundation: 12 feet of tough clay over limestone of Mississippi system, about 300 feet thick.

Instrument: Wiechert 80 kg. astatic, horizontal pendulum.

Instrumental constants.. V 80, T_0 7, ε 5:1

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
			H. m. s.	*Sec.*	μ	μ	*km.*	
1918. Sept. 7	.....	eP.....	17 28 18	.....	.....	.....	8,900	Reported from South Africa.
		S.....	17 38 24	.....	.....	.....	.....	
		L.....	17 53 48	30	.....	.....	.....	
		M.....	17 59 30	24	.....	*19,000	.....	
		M.....	18 07 18	18	*18,000	.....	.....	
		M.....	18 10 18	18	.....	*12,000	.....	
		M.....	18 25 30	18	.....	*8,000	.....	
		M.....	18 32 00	18	.....	*7,000	.....	
		F.....	20 25 ..	.....	.....	.....	.....	
12	.....	eL.....	18 25 30	1	.....	*2,000	.....	
		L.....	19 25 00	.....	.....	.....	.....	
1		L.....	19 42 06	0.5	.....	*1,000	.....	
		F.....	? ? ?	.....	.....	.....	.....	
30	.....	P.....	13 47 00	.....	.....	.....	3,860	
		S ?....	13 52 42	.....	.....	.....	.....	
		L.....	13 56 30	.....	.....	.....	.....	
		M.....	14 08 12	24	.....	*1,000	.....	
		F.....	? ? ?	.....	.....	.....	.....	

* Trace amplitude.

New York. *Buffalo. Canisius College.* John A. Curtin, S. J.

Lat., 42° 53′ 02″ N.; long., 78° 52′ 40″ W. Elevation, 190.5 meters.

Instrument: Wiechert 80 kg. horizontal.

Instrumental constants.. V 80, T_0 7, ε 5:1

(Report for September, 1918, not received.)

New York. *Fordham University.* Daniel H. Sullivan, S. J.

Lat., 40° 51′ 47″ N.; long. 73° 53′ 08″ W. Elevation, 29.3 meters.

Instrument: Wiechert, 80 kg

Instrumental constants.. E: V 72, T_0 5.0, ε 0; N: V 72, T_0 5.0, ε 0

(Report for September, 1918, not received.)

New York. *Ithaca. Cornell University.* Heinrich Ries.

Lat., 42° 26′ 58″ N.; long., 76° 29′ 09″ W. Elevation, 242.6 meters.

Instruments: Two Bosch-Omori, 25 kg., horizontal pendulum (mechanical registration).

Instrumental constants.. E: V 13, T_0 22, ε 4:1; N: V 14, T_0 25, ε 4:1

(Report for September, 1918, not received.)

Panama Canal. *Balboa Heights.* Governor, Panama Canal.

Lat., 8° 57′ 39″ N.; long., 79° 33′ 29″ W. Elevation, 27.6 meters.

Instruments: Two Bosch-Omori, 100 kg.

Instrumental constants.. V 35, T_0 20

Date.	Character.	Phase.	Time.	Period T.	Amplitude. E	Amplitude. N	Distance.	Remarks.
			H. m. s.	*Sec.*			*km.*	
1918. Sept. 7	.....	P_E....	8 29 07	.....	.....	.....	400	
		P_N....	8 29 15	.....	.....	.....	.....	
		L_E....	8 30 11	20	.....	.....	.....	
		L_N....	8 30 15	20	.....	.....	.....	
		M_N....	8 30 25	.....	.....	*400	.....	
		M_E....	8 30 27	.....	*200	.....	.....	
		F.....	8 34 00	.....	.....	.....	.....	
8	.....	P.....	0 03 28	20	.....	.....	.....	Trace indistinct.
		F.....	0 05 34	.....	.....	.....	.....	
8	.....	P_E....	17 35 04	.....	.....	.....	8,950	
		P_N....	17 35 16	.....	.....	.....	.....	
		L_E....	18 03 04	20	.....	.....	.....	
		L_N....	18 03 16	20	.....	.....	.....	
		M_E....	18 13 24	.....	*1,500	.....	.....	
		M_N....	18 14 52	.....	.....	*1,000	.....	
		F_N....	20 07 00	.....	.....	.....	.....	
		F_E....	20 20 00	.....	.....	.....	.....	

* Trace amplitude.

Panama Canal. *Balboa Heights.* Governor, Panama Canal—Contd.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. E	Amplitude. N	Distance.	Remarks.
			H. m. s.	*Sec.*	μ	μ	*km.*	
1918. Sept. 17	.....	P_E....	22 46 08	.....	.....	.....	330	
		P_N....	22 46 12	.....	.....	.....	.....	
		L_N....	22 46 22	20	.....	.....	.....	
		L_E....	22 47 06	20	.....	.....	.....	
		M_E....	22 47 14	.....	*2,000	.....	.....	
		M_N....	22 47 16	.....	.....	*2,000	.....	
		F_E....	22 55 00	.....	.....	.....	.....	
		F_N....	22 56 00	.....	.....	.....	.....	

* Trace amplitude.

Porto Rico. *Vieques. Magnetic Observatory.* U. S. Coast and Geodetic Survey. F. L. Adams.

Lat., 18° 09′ N.; long., 65° 27′ W. Elevation, 19.8 meters.

Instruments: Two Bosch-Omori.

Instrumental constants.. E: V 10, T_0 17; N: V 10, T_0 20

Date.	Character.	Phase.	Time.	Period T.	Amplitude. E	Amplitude. N	Distance.	Remarks.
			H. m. s.	*Sec.*	μ	μ	*km.*	
1918. Sept. 7....	.....	eP_N...	17 35 29	9	.....	.....	.....	Phases tabulated as eP may be P_{repl}.
		eP_E...	17 35 50	9	.....	.....	.....	
		S_E.....	17 43 14	16	.....	.....	.....	
		$S_{N repl}$.	17 50 48	16	.....	.....	.....	
		$S_{E repl}$.	17 51 00	16	.....	.....	.....	
		L_E....	18 07 38	40	.....	.....	.....	
		eL_E...	18 13 ..	.....	.....	.....	.....	
		M_N....	18 25 16	21	.....	400	.....	
		M_E....	18 32 14	17	480	.....	.....	
		C_E....	18 37 ..	17	.....	.....	.....	
		C_N....	18 39 ..	16	.....	.....	.....	
		F_E....	20 19 ..	17	.....	.....	.....	
		F_N....	20 28 ..	17	.....	.....	.....	

Vermont. *Northfield. U. S. Weather Bureau.* Wm. A. Shaw.

Lat., 44° 10′ N.; long., 72° 41′ W. Elevation, 256 meters.

Instruments: Two Bosch-Omori, mechanical registration.

Instrumental constants.. E: V 10, T_0 15; N: V 10, T_0 16

Date.	Character.	Phase.	Time.	Period T.	Amplitude. E	Amplitude. N	Distance.	Remarks.
			H. m. s.	*Sec.*	μ	μ	*km.*	
1918. Sept. 7...	.....	P_E....	17 28 36	.....	.....	.....	.....	N component not registering.
		eS_E?..	17 38 02	.....	.....	.....	.....	
		eL_E?..	17 50 ..	.....	.....	.....	.....	
		L_E....	18 00 ..	20	.....	.....	.....	
		L_E....	18 08 ..	16	.....	.....	.....	
		M_E....	18 15 ..	.....	*25,000	.....	.....	
		F_E....	20 15 ..	.....	.....	.....	.....	
30	.....	eL.....	14 13 ..	.....	.....	.....	.....	
		F.....	14 25 ..	.....	.....	.....	.....	

* Trace amplitude.

Canada. *Ottawa. Dominion Astronomical Observatory.* Earthquake Station. Otto Klotz.

Lat., 45° 23′ 38″ N.; long., 75° 42′ 57″ W. Elevation, 83 meters.

Instruments: Two Bosch photographic horizontal pendulums, one Spindler & Hoyer 80kg. vertical seismograph.

Instrumental constants.. V 120, T_0 26

Date.	Character.	Phase.	Time.	Period T.	Amplitude. E	Amplitude. N	Distance.	Remarks.
			H. m. s.	*Sec.*	μ	μ	*km.*	
1918. Sept. 2	.....	eL_N?..	15 08 ..	19	.....	.....	.....	
		L.....	15 20 to	.....	.....	.....	.....	
			15 53 ..	18	.....	.....	.....	
4	.....	e_N.....	20 11 28	.....	.....	.....	.....	
		F.....	20 18 30	.....	.....	.....	.....	
7	.....	*O*.....	*17 17 37*	.....	.....	.....	7,360	Difficult record. i_E evidently is not S, but can not be identified with any other phase. The same impulse appears on the records of Saskatoon and Halifax, particularly on E-W components.
		P.....	17 28 24	.....	.....	.....	.....	
		eS.....	17 37 11	.....	.....	.....	.....	
		i_E.....	17 38 50	.....	.....	.....	.....	
		L_E....	17 50 ..	40	.....	.....	.....	
		M.....	18 10 ..	16	550	500	.....	
		L.....	18 25	16	.....	.....	.....	
		L.....	19 00 ..	16	.....	.....	.....	
		L.....	19 25 ..	15	.....	.....	.....	
		L.....	19 45 ..	14	.....	.....	.....	
		L.....	19 50 ..	14	.....	.....	.....	
		L.....	20 10 ..	17	.....	.....	.....	
		L.....	20 35 ..	17	.....	.....	.....	
		L.....	21 20 ..	17	.....	.....	.....	
8	.....	F.....	1 20 ..	.....	.....	.....	.....	

TABLE 2.—*Instrumental seismological reports, September, 1918*—Continued.

Canada. *Ottawa. Dominion Astronomical Observatory*—Continued.

VERTICAL.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	*p.*	*Az.*	*dm.*	
Sept. 7	.....	*eP*.....	*17 28 45*	.....	.....	.....	.....	
		eL.....	*17 52 30*	.....	.....	.....	.....	
		L.....	*18 00* ..	*32*	.....	.....	.....	
		L.....	*18 06* ..	*16*	.....	.....	.....	
	•	*L*.....	*18 10* ..	*17*	.....	.....	.....	
		L.....	*18 15* ..	*17*	.....	.....	.....	
		L.....	*18 22* ..	*17*	.....	.....	.....	
		L.....	*18 27* ..	*17*	.....	.....	.....	
		L.....	*18 40* ..	*16*	.....	.....	.....	
		L.....	*18 53* ..	*15*	.....	.....	.....	
		F.....	*19 10* ..	.....	.....	.....	.....	
7	.....	*O*.....	*17 17 31*	.....	.....	.....	5,500	Saskatoon record furnished by Ottawa.
		P_N.....	17 26 31	.....	.....	.....	.....	
		S_E.....	17 33 40	.....	.....	.....	.....	
		i_E.....	17 35 13	.....	.....	.....	.....	
		L.....	17 42 30	.....	.....	.....	.....	
7	.....	*O*.....	*17 17 51*	.....	.....	.....	8,000	Halifax record furnished by Ottawa.
		P.....	17 29 12	.....	.....	.....	.....	
		S_E.....	17 38 32	.....	.....	.....	.....	
		i_E.....	17 39 48	.....	.....	.....	.....	
		L.....	17 52 ..	.....	.....	.....	.....	
8	.....	e_N.....	6 08 ..	.....	.....	.....	.....	
		e_E.....	6 11 30	.....	.....	.....	.....	
		eL.....	6 25 to	.....	.....	.....	.....	
			6 35 ..	13	.....	.....	.....	
		F.....	7	.....	.....	.....	.....	
11	.....	e.....	4 05 to	.....	.....	.....	.....	
			4 17 ..	8	.....	.....	.....	
		F.....	4 40 ..	.....	.....	.....	.....	
11	.....	eL_E...	5 04 ..	.....	.....	.....	.....	
		L_E.....	5 17 ..	22	.....	.....	.....	
		L.....	5 30 ..	.....	.....	.....	.....	
		F.....	5 40 ..	.....	.....	.....	.....	
12	.....	e_N.....	18 25 ..	.....	.....	.....	.....	
		eL.....	18 27 to	16	.....	.....	.....	
			18 55 ..	8	.....	.....	.....	
		F.....	19	.....	.....	.....	.....	
14	.....	*O*.....	*17 05 01*	.....	.....	.....	8,880	
		P_N.....	17 17 08	.....	.....	.....	.....	
		S.....	17 27 12	.....	.....	.....	.....	
		eL_E...	17 41 30	23	.....	.....	.....	
		L.....	17 44 ..	17	.....	.....	.....	
		L.....	17 55 ..	18	.....	.....	.....	
		L.....	18 03 ..	15	.....	.....	.....	
		L.....	18 30 ..	15	.....	.....	.....	
		L.....	18 43 ..	15	.....	.....	.....	
		F.....	19	.....	.....	.....	.....	
16	.....	eL_E...	14 13 ..	26	.....	.....	.....	
		L.....	14 19 ..	18	.....	.....	.....	
		L.....	14 25 ..	16	.....	.....	.....	
		F.....	14 35 ..	.....	.....	.....	.....	
22	.....	e.....	10 13 30	.....	.....	.....	.....	
		i.....	10 17 53	.....	.....	.....	.....	
		e.....	10 29 18	.....	.....	.....	.....	
		eL_N?..	11 07 ..	.....	.....	.....	.....	
		L_E.....	11 07 ..	27	.....	.....	.....	
		L.....	11 15 ..	27	.....	.....	.....	
		L.....	11 20 ..	27	.....	.....	.....	
		F.....	11 35 ..	.....	.....	.....	.....	
29	.....	*O*.....	*12 07 1?*	.....	.....	.....	8,720	
		P.....	12 19 17	.....	.....	.....	.....	
		S.....	12 29 13	.....	.....	.....	.....	
		eL.....	12 43 ..	44	.....	.....	.....	
		L.....	12 55 ..	19	.....	.....	.....	
		L.....	13 00 ..	17	.....	.....	.....	
		F.....	13 20 ..	.....	.....	.....	.....	
30	.....	*O*.....	*13 34 32*	.....	.....	.....	6,820	
		P.....	13 44 50	.....	.....	.....	.....	
		S.....	13 53 10	.....	.....	.....	.....	
		L.....	14 03 30	.....	.....	.....	.....	
		L.....	14 12 ..	18	.....	.....	.....	
		L.....	14 25 ..	15	.....	.....	.....	
		L.....	14 52 ..	12	.....	.....	.....	
		F.....	15 10 ..	.....	.....	.....	.....	

Canada. *Ottawa. Dominion Astronomical Observatory*—Continued.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	*p.*	*Az.*	*dm.*	
Sept. 30	.....	eL_N?..	18 42 ..	.....	.....	.....	.....	
		L_N.....	18 45 ..	32	.....	.....	.....	
		L_E.....	18 53 ..	25	.....	.....	.....	
		L.....	19 00 ..	17	.....	.....	.....	
		L_E.....	19 15 ..	15	.....	.....	.....	
		L_E.....	19 20 ..	15	.....	.....	.....	
		L.....	19 35 ..	18	.....	.....	.....	
		L.....	19 55 ..	17	.....	.....	.....	
		L_E.....	20 15 ..	14	.....	.....	.....	
		F.....	20 40 ..	.....	.....	.....	.....	

Canada. *Toronto. Dominion Meteorological Service.*

Lat., 43° 40′ 01″ N.; long., 79° 23′ 54″ W. Elevation, 113.7 meters. Subsoil: Sand and clay.

Instrument: Milne horizontal pendulum, North. In the meridian.

Instrumental constant.. T_0 18. Pillar deviation, 1 mm. swing of boom=0.50″.

1918.			*H. m. s.*	*Sec.*	*μ*	*μ*	*km.*	
Sept. 2	.....	L.....	15 19 42	.....	.....	.....	.....	Early phases missed.
		L.....	15 26 06	.....	*100	.....	.....	Light turned down at 14h. 51m.
		F.....	15 51 00	.....	.....	.....	.....	
5	.....	.....	.....	.....	.....	.....	.....	Microseisms going on from 12h. to 13h. when other stations recorded a small quake.
7	.....	e ?....	17 27 12	.....	.....	.....	7,140?	Real beginning of P may be masked by microseisms. The phase at 17h. 38m. 48s. may suggest a dual quake.
		P ?....	17 28 24	.....	.....	.....	.....	
		eP.....	17 29 18	.....	.....	.....	.....	
		i.....	17 32 36	.....	.....	.....	.....	
		S.....	17 37 00	.....	.....	.....	.....	
		i.....	17 38 48	.....	.....	.....	.....	
		iL ?...	17 40 48	.....	.....	.....	.....	
		i.....	17 49 48	.....	.....	.....	.....	
		iL.....	17 53 00	.....	.....	.....	.....	
		iL.....	18 02 12	.....	.....	.....	.....	
		iL.....	18 08 18	.....	.....	.....	.....	
		iL.....	18 11 36	.....	.....	.....	.....	
		M_1....	18 13 36	.....	.....	.....	.....	
		to	18 15 00	.....	*25,000	.....	.....	
		iL.....	18 16 24	.....	.....	.....	.....	
		M_2....	18 17 30	.....	.....	.....	.....	
		iL.....	18 18 36	.....	.....	.....	.....	
		iL.....	19 54 06	.....	.....	.....	.....	
		iL.....	20 00 54	.....	.....	.....	.....	
		L_{rep1}..	22 38 18	.....	.....	.....	.....	
		F.....	22 56 36	.....	.....	.....	.....	
8	.....	eL.....	0 49 48	.....	.....	.....	.....	Distant. Gradual thickening.
		iL.....	1 01 54	.....	.....	.....	.....	
		M.....	1 04 30	.....	*300	.....	.....	
		L.....	1 16 36	.....	.....	.....	.....	
		F ?....	1 45 30	.....	.....	.....	.....	
8	.....	eL.....	6 13 42	.....	.....	.....	.....	Gradual thickening.
		eL.....	6 25 30	.....	.....	.....	.....	
		eL.....	6 27 54	.....	.....	.....	.....	
		M.....	6 28 06	.....	*300	.....	.....	
		eL.....	6 32 06	.....	.....	.....	.....	
		F.....	6 59 18	.....	.....	.....	.....	
8	.....	.....	.....	.....	.....	.....	.....	Microseisms began at 14h. 42m. and were very heavy during night until morning of 9th.
11	.....	.....	.....	.....	.....	.....	.....	Microseisms during morning hours.
12	.....	eL.....	18 26 18	.....	.....	.....	.....	
		eL.....	18 28 18	.....	.....	.....	.....	
		M.....	18 28 42	.....	*200	.....	.....	
		eL?....	19 09 06	.....	.....	.....	.....	
		F.....	19 11 18?	.....	.....	.....	.....	
14	.....	e.....	17 21 24	.....	.....	.....	.....	Microseisms going on before e.
		eS.....	17 26 06	.....	.....	.....	.....	
		L.....	17 42 06	.....	.....	.....	.....	
		eL.....	17 48 00	.....	.....	.....	.....	
		L.....	17 54 54	.....	.....	.....	.....	
		M.....	17 55 54	.....	*300	.....	.....	
		F.....	19 16 30	.....	.....	.....	.....	
16	.....	L.....	14 11 12	.....	.....	.....	.....	
		L.....	14 13 18	.....	.....	.....	.....	
		eL.....	14 16 42	.....	.....	.....	.....	
		M.....	14 18 30	.....	*300	.....	.....	
		F.....	14 41 54	.....	.....	.....	.....	

TABLE 2.—*Instrumental seismological reports, September, 1918*—Continued.

Canada. *Toronto. Dominion Meteorological Service*—Continued.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Sept. 22	.....	L.....	10 34 42	.....	.....	.....	.....	Microseisms going on.
		L.....	10 52 48	.....	.....	.....	.....	
		eL.....	11 18 36	.....	.....	.....	.....	
		M.....	11 19 42	.....	*200	.....	.....	
		F.....	11 48 54?	.....	.....	.....	.....	
29	.....	S?.....	12 30 12	.....	.....	.....	.....	Distant.
		e.....	12 35 00	.....	.....	.....	.....	
		L.....	12 44 06	.....	.....	.....	.....	
		eL.....	12 54 18	.....	.....	.....	.....	
		eL.....	12 56 54	.....	.....	.....	.....	
		M.....	12 57 30	.....	*300	.....	.....	
		F.....	13 30 24?	.....	.....	.....	.....	
30	.....	P?.....	13 45 00?	.....	.....	.....	.....	Time of P and F very doubtful.
		eS.....	13 53 42	.....	.....	.....	.....	
		eL.....	14 02 00	.....	.....	.....	.....	Microseisms going on.
		M.....	14 16 30	.....	*600	.....	.....	
		L.....	14 30 48	.....	.....	.....	.....	
		F.....	? ? ?	.....	.....	.....	.....	
30	.....	e.....	18 44 00	.....	.....	.....	.....	May be a dual quake.
		L.....	18 52 48	.....	.....	.....	.....	
		eL.....	18 56 36	.....	.....	.....	.....	
		M_1.....	19 02 24	.....	*2,000	.....	.....	
		eL.....	19 42 36	.....	.....	.....	.....	
		eL.....	19 49 00	.....	.....	.....	.....	
		M_2.....	19 53 00	.....	*800	.....	.....	
		iL.....	19 57 00	.....	.....	.....	.....	
		F?.....	21 13 30	.....	.....	.....	.....	

* Trace amplitude.

Canada. *Victoria, B. C. Dominion Meteorological Service.*

Lat., 48° 24′ N.; long., 123° 19′ W. Elevation, 67.7 meters. Subsoil: Rock.

Instrument: Wiechert, vertical; Milne horizontal pendulum, North. In the meridian.

Instrumental constant.. T_0 18. Pillar deviation, 1 mm., swing of boom=0.54″.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. μ	Amplitude. μ	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Sept. 2	.....	P?.....	14 57 22	.....	.....	.....	.....	
		M.....	15 07 42	.....	*200	.....	.....	
		F?.....	15 21 28	.....	.....	.....	.....	
5	.....	M.....	12 30 56	.....	*100	.....	.....	
7	.....	P.....	17 23 38	.....	.....	.....	.....	
		S.....	17 26 02	.....	.....	.....	.....	
		i.....	17 27 44	.....	.....	.....	.....	
		L.....	17 33 28	.....	.....	.....	.....	
		M_1.....	17 53 08	.....	*30,000	.....	.....	
		M_2.....	17 57 02	.....	.....	.....	.....	
		F.....	22 29 32	.....	.....	.....	.....	
			VERTICAL.					
						Az		
		P.....	*17 23 30*	*3*	.....	.....	*1,450*	*Lines crossed at time of quake.*
		S.....	*17 26 00*	*8*	.....	.....		
		L.....	*17 ? ?*	.....	.....	.....		
		M.....	*17 42 00*	*24*	.....	*34*		
		F.....	*? ? ?*	.....	.....	.....		
8	.....	P or L?	0 11 56	.....	.....	.....	.....	Probably aftershock from above.
		M.....	0 50 07	.....	*200	.....	.....	
		F.....	1 20 50	.....	.....	.....	.....	
8	.....	P.....	6 03 00	.....	.....	.....	.....	Do.
		L.....	6 14 30	.....	.....	.....	.....	
		M.....	6 21 30	.....	*200	.....	.....	
		F.....	7 01 00	.....	.....	.....	.....	
8	.....	L?.....	22 27 37	.....	.....	.....	.....	Do.
		eL.....	22 42 30	.....	.....	.....	.....	Microseisms from 21h. 20m. 8th to 0h. 40m. 9th.
		M.....	22 56 08	.....	*200	.....	.....	
9	.....	F.....	0 33 31	.....	.....	.....	.....	
9	.....	L.....	0 01 05	.....	*200	.....	.....	
		F.....	0 04 05	.....	.....	.....	.....	
9	.....	.....	.....	.....	.....	.....	.....	Local tremor felt in parts of city at 12h. 30m. duration 1 sec. and accompanied by a rumbling noise. Not recorded.
12	.....	M.....	13 51 31	.....	*100	.....	.....	Probably aftershock.

Canada. *Victoria, B. C. Dominion Meteorological Service*—Contd.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	*Az.*	*km.*	
Sept. 12	.....	P.....	18 08 15	.....	.....	.....	1,410	Alaska?
		L.....	18 10 43	.....	.....	.....	.....	
		M.....	18 12 11	.....	*200	.....	.....	
		F.....	18 22 01	.....	.....	.....	.....	
14	.....	P.....	17 21 17	.....	.....	.....	2,770	
		S.....	17 25 43	.....	.....	.....	.....	
		L.....	17 37 01	.....	.....	.....	.....	
		M.....	17 44 53	.....	*500	.....	.....	
		F.....	18 38 00	.....	.....	.....	.....	
15	.....	M?.....	6 13 29	.....	*50	.....	.....	
16	.....	P.....	14 01 49?	.....	.....	.....	.....	
		M.....	14 12 38	.....	*200	.....	.....	
		F.....	14 23 57	.....	.....	.....	.....	
22	.....	P.....	10 58 51	.....	.....	.....	1,720	
		S.....	11 01 49	.....	.....	.....	.....	
		L.....	11 07 43	.....	.....	.....	.....	
		M.....	11 12 08	.....	*200	.....	.....	
		F.....	11 29 50	.....	.....	.....	.....	
28	.....	P.....	10 56 30	.....	.....	.....	.....	
		M.....	10 59 27	.....	*100	.....	.....	
		F.....	11 03 24	.....	.....	.....	.....	
29	.....	eL.....	12 50 21	.....	.....	.....	.....	
		eL.....	12 52 08	.....	.....	.....	.....	
		L.....	12 57 03	.....	.....	.....	.....	
		M.....	13 06 54	.....	*500	.....	.....	
		F.....	13 30 30	.....	.....	.....	.....	
30	.....	P.....	13 31 33	.....	.....	.....	1,710	
		S.....	13 34 30	.....	.....	.....	.....	
		L.....	13 39 25	.....	.....	.....	.....	
		M.....	13 55 39	.....	*600	.....	.....	
		F.....	14 54 10	.....	.....	.....	.....	
30	.....	P.....	18 04 32	.....	.....	.....	2,760	
		S.....	18 08 57	.....	.....	.....	.....	
		L.....	18 15 31	.....	.....	.....	.....	
		M.....	18 47 18	.....	*1,000	.....	.....	
		F.....	? ? ?	.....	.....	.....	.....	
30	.....	L.....	19 15 50	.....	.....	.....	.....	P and S probably masked by end of previous quake.
		M.....	19 40 55	.....	*1,500	.....	.....	
		F.....	20 42 23	.....	.....	.....	.....	

* Trace amplitude.

TABLE 3.—*Late seismological reports (instrumental).*

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E.	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Aug. 8	.....	eL_E...	10 33 20	24	10	.....	.....	
		M_E....	10 41 37	19	.....	.....	.....	
		F_E....	10 55 ..	16	.....	.....	.....	
15	.....	eP_E...	12 38 30	6	.....	.....	.....	Paper on E was changed between 14h. 08m. and 14h. 26m. End occurred during this time.
		eP_N...	12 39 40	5	.....	.....	.....	
		S_E.....	12 48 23	16	.....	.....	.....	
		S_N.....	12 48 26	.....	.....	.....	.....	
		eL_E...	13 14 37	25	.....	.....	.....	
		eL_N...	13 16 24	24	.....	.....	.....	
		M_E....	13 26 30	18	150	.....	.....	
		M_N....	13 47 24	16	.....	20	.....	
		C_E....	13 53 ..	16	.....	.....	.....	
		C_N....	13 56 ..	16	.....	.....	.....	
		F_N....	14 09 ..	16	.....	.....	.....	
23	.....	eL_E...	7 18 46	24	.....	.....	.....	
		M_E....	7 40 49	16	10	.....	.....	
		F_E....	8 05 ..	15	.....	.....	.....	

Arizona. *Tucson. Magnetic Observatory.* U. S. Coast and Geodetic Survey. F. P. Ulrich.

Lat. 32° 14′ 48″ N.; long. 110° 57′ 06″ W. Elevation, 769.6 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants { E V 10, T_0 14; N V 10, T_0 19

TABLE 2.—*Instrumental seismological reports, September, 1918*—Con.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.

Massachusetts. *Cambridge. Harvard University Seismographic Station,* J. B. Woodworth.

Lat., 42° 22′ 36″ N.; long., 71° 06′ 59″ W. Elevation, 5.4 meters. Foundation: Glacial sand over clay.

Instruments: Two Bosch-Omori 100 kg. horizontal pendulums (mechanical registration).

Instrumental constants..

	V	T_0	ε
E	80	23	0
N	50	25	4:1

1918.			H. m. s.	Sec.	μ	μ	km.	
Aug. 4	.....	.....	16 postea	.....	.....	.....	.....	8 sec. periods for about 15 minutes.
5	.....	L_E.....	2 35 ..	20	.....	.....	.....	Clock contacts failed; time approximate only.
		to.....	2 50 ..	.....	.....	.....	.....	
8	.....	e_N?....	10 25 17	.....	.....	.....	.....	
		eL_N...	10 38 21	40	.....	.....	.....	
		L_N....	10 43 31	20	.....	.....	.....	
		L_N....	10 46 21	30	.....	.....	.....	
		L_N....	10 49 55	25	.....	.....	.....	
		L_E....	10 51 00	30	.....	.....	.....	
		L_N....	10 56 47	20	.....	.....	.....	Amplitude N increases.
		to.....	10 59 11	18	.....	.....	.....	
		F_N....	11 37 ..	.....	.....	.....	.....	
14	.....	L_E....	18 15 51	.....	.....	.....	.....	
		F.....	19 19 ..	.....	.....	.....	.....	
14	.....	e_E?....	20 54 37	.....	.....	.....	.....	Possibly artificial.
		L_E....	20 54 53	8-13	.....	.....	.....	Some record on N also.
		F.....	21 15 ..	.....	.....	.....	.....	
15	.....	O.....	12 26 21	.....	.....	.....	6,426	Break in record from 13 h. 01 m. to 13 h. 05 m. changing sheets, and on E from 14 h. 56 m. to 15 h. 44 m. stylus tipped over.
		P_N....	12 35 44	2	.....	.....	.....	
		i.....	12 37 56	.....	.....	.....	.....	
		i.....	12 38 07	2	.....	.....	.....	
		S_N....	12 42 43	20	.....	.....	.....	
		eL_N...	12 52 22	.....	.....	.....	.....	
		eM_N...	12 58 ..	22	.....	.....	.....	
		M_E....	13 28 ..	.....	.....	.....	.....	
		M_E....	13 30 30	28	.....	.....	.....	
		M_E....	13 38 30	30	.....	.....	.....	
		M_E....	13 46 36	16	.....	.....	.....	
		M_E....	13 54 ..	.....	.....	.....	.....	
		L_E....	14 04 30	.....	.....	.....	.....	
		L_E....	16 34 ..	24	.....	.....	.....	
		to.....	16 46 ..	.....	.....	.....	.....	
		F_E....	17 15 ..	.....	.....	.....	.....	
15	.....	O?....	17 48 24	.....	.....	.....	9,850?	
		S_E?....	18 10 50	8	.....	.....	.....	
		L_E....	18 30 18	26	.....	.....	.....	
		L_N....	18 30 54?	.....	.....	.....	.....	
		L_E....	18 34 30	30	.....	.....	.....	
		M_E?...	18 39 53	24	.....	.....	.....	
		L_E....	18 49 ..	20	.....	.....	.....	
		L_E....	18 57 ..	15	.....	.....	.....	
		F.....	19 52 ..	.....	.....	.....	.....	
21	.....	O.....	4 11 54	.....	.....	.....	225	Local shock near South Paris, Me. (44° 07′ 40″ N., 70° 32′ 18″ W.).
		P_E....	4 12 28	.....	.....	.....	.....	
		M_E....	4 12 53	.....	.....	.....	.....	
		C.....	4 13 04	8	.....	.....	.....	
		to.....	4 13 45	.....	.....	.....	.....	
		F.....	4 14 08	.....	.....	.....	.....	
23	.....	O.....	6 48 47	.....	.....	.....	10,960	Volcanoes "Llame" (Llaimas?) and Lanin in Andes reported in eruption. Lanin 71° 30′ W., 39° 45′ S. About 9,000 kms.
		eP_E...	7 02 ..	.....	.....	.....	.....	
		e_E....	7 06 13	.....	.....	.....	.....	
		S_E....	7 14 14	20	.....	.....	.....	
		S_N....	7 14 59	.....	.....	.....	.....	
		eL_E...	7 36 51	40	.....	.....	.....	
		L_E....	7 42 ..	20	.....	.....	.....	
		L_E....	7 48 54	15	.....	.....	.....	
		F.....	8 50 ..	.....	.....	.....	.....	

SEISMOLOGICAL DISPATCHES.[1]

Buenos Aires, August 23, 1918 (belated dispatch).

Government telegraph stations report that the eruption of Mounts Llame and Lanan, in the territory of Neuquen, are not serious. The inhabitants of two towns near the mountains were reported to have left their homes. (Assoc. Pr.)

Honolulu, T. H., August 30, 1918 (belated dispatch).

The great active volcano of Kilauea, on the island of Hawaii, which caused a sensation in the scientific world last February by suddenly discharging a lava flow from its inner pit, is now showing preliminary signs of another eruption. (Assoc. Pr.)

No press reports of seismological or volcanological disturbances were received during September, 1918.

RECORD OF SEA WAVES PRODUCED BY THE EARTHQUAKE OF SEPTEMBER 7, 1918.

[Communicated by the United States Coast and Geodetic Survey.]

The tide gages of the United States Coast and Geodetic Survey at San Francisco, Cal., and Honolulu, Hawaii, recorded a marked tidal disturbance on the two days following the earthquake of September 7, 1918. The disturbance began with a rise of tide in each case.

At Honolulu the beginning occurred at $1^h\ 25^m$ p. m., Hawaiian standard time, or $23^h\ 55^m$ G. M. T. The maximum amplitude of about 0.9 foot came not quite an hour later. The waves were quite regular, as a rule, with an average period of about 25 minutes, and were still in evidence, though of small amplitude, two days after the beginning.

At San Francisco the beginning occurred about $6^h\ 40^m$ p. m., 120th meridian standard time, or $2^h\ 40^m$ G. M. T., September 8. The maximum amplitude of about 3 inches came not quite an hour later. The waves were very irregular, so that only an approximate determination of the period was possible, somewhere between 15 and 20 seconds.

Records of this earthquake from the seismographs at the magnetic observatories of this bureau indicate that the earthquake occurred at about $17^h\ 17^m$ G. M. T., so that it took the sea waves $6^h\ 38^m$ to reach Honolulu and $9^h\ 23^m$ to reach San Francisco.

[1] Reported by the organization indicated and collected by the seismological station at Georgetown University, Washington, D. C.

SECTION VI.—BIBLIOGRAPHY.

RECENT ADDITIONS TO THE WEATHER BUREAU LIBRARY.

C. FITZHUGH TALMAN, Professor in Charge of Library.

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

Bock, C. A.
History of the Miami flood control project. Dayton, Ohio. 1918. 194 p. fold. front. illus. 23 cm. (State of Ohio. The Miami conservancy district. Technical reports. Part 2.)

Coimbra. Observatorio meteorologico.
Observações meteorologicas, magneticas e sismicas feitas no anno de 1917. Volume 56. Coimbra. 1918. viii, 164 p. incl. tables. 36½ cm.

Gran, H. H. & Gaarder, Torbjörn.
Über den Einfluss der atmosphärischen Veränderungen Nordeuropas auf die hydrographischen Verhältnisse des Kristianiafjords bei Drōbak im März 1916. (Mitteilung aus der Biologischen Station zu Drōbak) Copenhague. 1918. 28 p., 1. incl. charts. 26½ cm. At head of title: Conseil permanent international pour l'exploration de la mer. Publications de circonstance. No. 71.

Great Britain. Meteorological office.
Thirteenth annual report of the meteorological committee to the lords commissioners of His Majesty's treasury. For the year ended 31st March, 1918 . . . London. 1918. 20 p. 24½ cm.

Hildebrandsson, H[ugo] Hildebrand.
Résultats des recherches empiriques sur les mouvements généraux de l'atmosphère . . . Uppsala. 1918. 1., 50 p. charts. tables. 29cm. At head of title: Nova acta Regiae societatis scientiarum Upsaliensis. Ser. 4. Vol. 5. No. 1.

Hubert, Henry.
Mission scientifique au Soudan . . . Premier fascicule [L'atmosphère] Paris. 1916. 2 p. l., 319 p. plates. map. fold. charts. tables. diagrs. 25½ cm. [Elaborate text discussion with charts and tables showing monthly normals of principal meteorological elements for French West Africa and the Guinea coast.]

Indo-China. Service météorologique.
Bulletin pluviométrique . . . Tableaux mensuels, annuels et carte. Année 1917. Phu-Lien. 1918. [1., 6] p. fold. charts. tables. 40 cm. At head of title: Gouvernement général de l'Indochine. Observatoire central de l'Indochine.

Lloyd, Francis E[rnest].
The structure of hailstones of exceptional form and size. Ottawa. 1916. cover-title. diagrs. 25 cm. (From the Transactions of the Royal society of Canada. Series 3. 1916. Volume 10, p. [47]–50.)

Loft, Genivera.
The Gulf Stream and the North Atlantic drift. (Excerpted from the Journal of geography, Madison, Wis. Vol. 17, no. 1. Sept. 1918. p. 8–17. 25½ cm.)

Moreux, Th[éophile].
Méthode simple pour prévoir le temps. Paris. 1918. 1., p. 7–32 [1]. front. plates. 18 cm.

Norway. Meteorologiske institut.
Jahrbuch des Norwegischen meteorologischen instituts für 1917 . . . Kristiania. 1918. xi, 170 p. incl. tables. 33½ cm. Ned børiagttagelser i Norge. Aargang 23. 1917. Kristiania. [1918] 2 p. l., xi, 45 p. 2 fold. charts. tables. 37½ cm. Oversigt over luftens temperatur og nedbøren i Norge i aaret 1916. 22 p., 1. incl. 5 tables. 23½ cm. (Sœrtryk av Landbruksdirektørens beretning for 1916.)

Ohio. Agricultural experiment station.
Ohio weather for 1917. Wooster, Ohio. 1918. p. 487–576. 63 charts. 14 tables. 23 cm. Bulletin 324.

Philippine Islands. Weather bureau.
Annual report of the Weather Bureau . . . Part 1–2. Manila. 1917. 144 p. incl. tables. 29 cm. At head of title: Department of agriculture and natural resources. Weather bureau . . .

Quaife, Milo M[ilton].
Increase Allen Lapham, first scholar of Wisconsin. cover-title. 13 p. port. 26 cm. (Reprinted from the Wisconsin magazine of history, vol. 1. Sept. 1917.)

Radcliffe observatory, Oxford.
Results of meteorological observations in the year 1917 . . . Vol. 52. Part 2. Oxford. 1918. cover-title. p. [21]–40. incl. tables. 26 cm.

U. S. Bureau of the census.
Census of the Virgin Islands of the United States, November 1, 1917. Prepared under the supervision of Eugene F. Hartley. Washington. 1918. 174 p. plates. 2 maps. tables. 23½ cm. [Climate and rainfall, p. 16–18.]

RECENT PAPERS BEARING ON METEOROLOGY AND SEISMOLOGY.

C. F. TALMAN, Professor in Charge of Library.

The following titles have been selected from the contents of the periodicals and serials recently received in the Library of the Weather Bureau. The titles selected are of papers and other communications bearing on meteorology and cognate branches of science. This is not a complete index of all the journals from which it has been compiled. It shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau.

American journal of science. New Haven. v. 46. October, 1918.
Winchell, A. N. & Miller, E. R. The dustfall of March 9, 1918. p. 599–609.

Engineering news-record. New York. v. 81. 1918.
Stuart, Edward. Guatemala earthquakes destroyed all masonry buildings, wood and concrete stood shocks well. p. 623–626. (Oct. 3.)
Gannett, Farley. Recent Erie flood similar to inundation of 1915. p. 667–668. (Oct. 10.)
Harner, W. W. Extraordinary rainfall flooded portions of St. Louis. p. 672–673. (Oct. 10.)

Geographical review. New York. v. 6. September, 1918.
Jefferson, Mark. The real temperatures throughout North and South America. p. 240–267.

Agricultural intelligence and plant diseases. Rome. Monthly bulletin. year 9. April, 1918.
Marcarelli, B. The effects of meteorological factors on the growth and yield of rice. p. 539–541.

Nature. London. v. 102. 1918.
Chree, C[harles]. Auroral observations in the Antarctic. p. 24–25. (Sept. 12.) [Discusses alleged observations of the aurora at low levels in the atmosphere.]
Meek, A. A shower of sand eels. p. 46. (Sept. 19.)

Schweizer. Aero-Klub. Bern. 12. Jahrg. August, 1918.
Schutt, K. Struktur der Atmosphäre. p. 114–117. [Repr. from "Umschau."]

Science. New York. v. 48. 1918.
Barus, C[arl]. Hygrometry in terms of the weight of a film of gelatine. p. 374–376.
Bigelow, Frank H. Mr. Abbot's theory of the pyrheliometer. p. 417–418. (Oct. 25.)

Reale accademia dei Lincei. Roma. Atti. v. 27. 1918.
Somigliana, C. Sulla propagazione delle onde sismiche. Nota 3. p. 13–20. (Gen. 6.)
Tenani, Mario. Sulla misura barometrica delle altezze a scopo aeronautico. Nota 2. p. 51–55. (Gen. 6.)
Pantanelli, E. Su la resistenza delle piante al freddo. Nota 1, 2. p. 126–130; 148–153. (Feb. 3. '17.)

SECTION VII.—WEATHER AND DATA FOR THE MONTH.

WEATHER OF SEPTEMBER, 1918.

P. C. DAY, Climatologist and Chief of Division.

[Dated: Climatological Division, Washington, Nov. 1, 1918.]

PRESSURE AND WINDS.

The distribution of the mean atmospheric pressure over the United States and Canada, and the prevailing direction of the winds for September, 1918, are graphically shown on Chart VII, while the means at the several stations, with the departures from the normal, are shown in Tables I and III.

The average barometric pressure for September was above the normal throughout the whole country, except from the Lower Lakes eastward to the Atlantic Coast, and locally in the Pacific Coast States, where it was slightly below. The departures were generally small, however, except over the Missouri Valley, and thence into the Canadian Northwest Provinces, where they were comparatively large. A more detailed discussion of the daily movements of the important cyclones and anticyclones will be found under Forecasts and Warnings.

The general distribution of the barometric pressure favored northerly winds along the Atlantic and east Gulf coasts as well as in the upper Lake region and westward to the Rocky Mountains, while in the Great Central Valleys and the southern Plains States they were locally from the South. Elsewhere variable winds prevailed. The month was notably free from high winds or destructive storms, the maximum velocities reported reaching 50 miles or more in only a few instances.

TEMPERATURE.

September opened with cold weather in the northern Plains States and the Northwest, accompanied by killing frost or freezing temperature in portions of North Dakota and Montana, but in most eastern districts the temperature was generally above the normal. Cooler weather overspread most central and eastern districts about the middle of the first decade, but during the next few days somewhat higher temperature prevailed. However the decade closed cool for the season over the northern portion of the country, with heavy frost in upper Michigan and the northern portions of Minnesota and Wisconsin. Early in the second decade temperatures were below normal generally east of the Rocky Mountains, except in the Northeast, while over the Pacific Coast States they were generally above. During the next few days there was some warming up in most interior districts, but about the middle of the month colder weather again overspread the western districts, and freezing temperatures were reported as far south as northeastern Colorado and northern Nebraska. For several days following, the weather was much colder from the Rocky Mountains and Texas northeastward. The decade closed unseasonably cool in the northern Plains States, with freezing temperature over considerable areas; but it was warmer in the far Northwest.

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At the beginning of the third decade cooler weather overspread the Atlantic Coast and Gulf States, and the lowest September temperatures of record occurred at some points in the latter district. Elsewhere the weather continued generally cooler than normal, except in the Plains region where seasonal warmth prevailed. Somewhat warmer weather overspread most central districts about the middle of the decade, but toward the latter part of the month there was a substantial fall in temperature over the interior districts and the Middle and North Atlantic Coast States, with frost in the upper Mississippi Valley and the Lake region. The month closed with cooler weather and frost in the Northwest, the Ohio Valley, the Lake region, and the interior portions of Pennsylvania and New York.

As a whole, September was abnormally cool in nearly all districts east of the Rocky Mountains, particularly from the central Mississippi and Ohio valleys northward and northwestward, where the deficiencies of temperature averaged from 6 to 8 degrees a day. In many of the States the average temperature for the month was lower than for any other September in the past 30 years or more. Killing frost and freezing temperature occurred during the first decade of the month in North Dakota and northwestern Minnesota, and by the close of the month the frost line had advanced southward over most of Kansas, to northwestern Missouri, eastern Iowa, northern Indiana, northwestern Ohio, and over the Appalachian Mountain district southward as far as West Virginia. To the westward of the Rocky Mountains, however, the month was warmer than usual in most districts, especially in the far Northwest, where the temperature in some localities averaged 6 degrees a day above the normal.

PRECIPITATION.

During the first few days of the month rain fell quite generally east of the Rocky Mountains, the falls being heavy to excessive in portions of the lower Missouri and upper Mississippi valleys, and again for several days following the middle of the decade showers prevailed over much of the East and Northeast sections. The decade closed with rain in the central Rocky Mountain and Plateau States, the upper Mississippi Valley, and the Lake region. During the early part of the second decade rain fell over the central and northern districts east of the Mississippi River, and within the following few days rain occurred in California and the central plateau and Rocky Mountain States, the falls being unusually heavy for the season in northern California. About the middle of the month unsettled, showery weather prevailed in central and northern districts from the Rocky Mountains eastward, and continued quite generally over this area until the close of the second decade. During the first few days of the third decade rain fell in the central and northern plateau and Rocky Mountain districts, and local showers occurred in the Lake region and to the eastward. About the middle of the decade rain was quite general in the Southern States, heavy in some localities, and unsettled,

showery, weather prevailed in the Northeast. Showery weather continued for several days in the Northeast and Southeast, and the month closed with rain in the central and northern Rocky Mountain and plateau regions.

For the month, as a whole, there was a moderate amount of rainfall in most sections east of the Rocky Mountains, except in the north Central States and over much of Louisiana and Texas. Rather heavy amounts occurred in the lower Missouri and central Mississippi valleys, and northeastward over the lower Lakes to New England, and in portions of the South Atlantic and East Gulf States. The largest totals for the month occurred in southeastern Florida, where more than 12 inches fell. Heavy rain for the season occurred in northern California, where at points the fall was greater than for any previous September in the past 40 years; and amounts somewhat above normal were received locally in the northern plateau and Rocky Mountain districts. Very little rain occurred in the far Northwest, where considerable amounts are usually received during September, and in much of the far Southwest the month was practically rainless.

Heavy snow was reported from some of the mountains of northern California near the middle of the month, and near the close there was a light fall generally over the high Sierra.

RELATIVE HUMIDITY.

The relative humidity was generally above the normal from the Lake region and Ohio Valley northeastward, and from the Rocky Mountains westward, except in the far Northwest. Elsewhere the atmosphere was relatively drier than usual for this season of the year. Over central and northern California, and at points in the plateau region, the relative humidity was from 10 to 20 per cent above normal, while in portions of the lower Missouri Valley the deficiency was nearly as great.

GENERAL SUMMARY.

September, 1918, was unseasonably cool in most central and northern districts and corn matured rather slowly, particularly in the eastern sections, However, the crop was so far advanced over the principal corn-growing States that on the whole no great damage resulted from frost, although in small areas the damage was considerable.

The weather was rather unfavorable for further cotton growth throughout much of the belt, and the condition of the crop in many sections was not satisfactory. However the weather was generally favorable for picking and ginning. Conditions were generally favorable for winter-grain seeding and this work made good progress. Potatoes and garden truck were damaged by frost in some northern sections. Pastures generally remained in good condition during the month and live stock continued to improve. The weather was mostly favorable for harvesting of fruit, although in California considerable damage resulted to drying fruit and to other agricultural products, due to frequent showers and lack of sunshine.

Average accumulated departures for September, 1918.

Districts.	Temperature.			Precipitation.			Cloudiness.		Relative humidity.	
	General mean for the current month.	Departure for the current month.	Accumulated departure since Jan. 1.	General mean for the current month.	Departure for the current month.	Accumulated departure since Jan. 1.	General mean for the current month.	Departure from the normal.	General mean for the current month.	Departure from the normal.
	°F.	°F.	°F.	Ins.	Ins.	Ins.	0-10.		P. ct.	
New England	58.3	−2.2	−10.7	5.60	+2.40	− 2.90	6.4	+1.2	81	0
Middle Atlantic	62.8	−3.5	− 4.1	3.49	+0.10	− 4.00	5.1	+0.4	75	− 3
South Atlantic	70.2	−2.9	+ 1.6	3.62	−1.00	−12.20	4.7	+0.1	78	− 3
Florida Peninsula	80.5	−0.7	+ 3.3	6.33	−1.60	−15.00	5.2	0.0	77	− 4
East Gulf	71.8	−3.0	+ 4.3	4.18	+0.30	− 4.50	4.8	+0.3	75	− 3
West Gulf	72.8	−2.6	+ 5.2	2.58	−0.90	− 9.00	3.6	−0.5	67	− 7
Ohio Valley and Tennessee	62.1	−5.8	− 5.5	2.96	+0.20	− 3.90	5.3	+0.9	74	0
Lower Lakes	56.8	−6.3	− 9.7	4.74	+1.90	− 1.40	6.5	+1.6	74	0
Upper Lakes	53.3	−5.7	−11.3	2.65	−0.60	− 3.40	5.9	+0.7	72	− 6
North Dakota	52.3	−4.9	+ 7.0	0.38	−1.00	− 3.10	4.2	−0.2	68	− 1
Upper Mississippi Valley	58.9	−5.9	− 2.6	2.77	−0.60	− 2.30	5.0	+0.6	73	− 2
Missouri Valley	60.8	−4.5	+10.2	3.08	+0.40	− 4.70	4.3	+0.1	64	− 4
Northern slope	55.8	−1.6	+ 4.3	1.37	+0.40	+ 1.40	4.9	+0.8	66	+ 7
Middle slope	63.2	−4.4	+ 7.1	2.39	+0.40	− 1.20	4.1	+0.7	65	+ 4
Southern slope	70.5	−2.3	+11.4	0.95	−1.80	− 7.10	3.3	−0.3	59	− 6
Southern Plateau	71.0	+0.5	− 0.3	0.52	−0.50	− 0.60	2.4	−0.1	48	+ 6
Middle Plateau	63.5	+1.2	+ 2.8	1.48	+0.80	− 0.40	3.9	+0.9	46	+ 4
Northern Plateau	64.6	+3.4	+13.6	0.35	−0.10	− 1.30	4.1	+0.4	53	+ 3
North Pacific	61.4	+3.8	+10.7	0.29	−2.10	− 4.40	4.9	−0.5	74	− 5
Middle Pacific	62.9	−0.6	+ 3.8	4.04	+3.40	− 3.10	5.6	+2.4	75	+12
South Pacific	70.3	+3.0	+16.5	0.47	+0.30	+ 2.80	4.3	+1.6	71	+ 5

WEATHER CONDITIONS OVER THE NORTH ATLANTIC DURING SEPTEMBER, 1917.

The data presented are for September, 1917, and comparison and study of the same should be in connection with those appearing in the Review for that month. Chart IX (XLVI—83) shows for September, 1917, the averages of pressure, air temperature, water surface-temperature, and the prevailing direction of the wind at 7 a. m. 75th Meridian Time (Greenwich mean noon). Notes on the locations and courses of the more severe storms of the month are included in the following general summary.

PRESSURE.

The distribution of the mean atmospheric pressure for the month presented few unusual features, especially in the southern division of the ocean, as the North Atlantic and Continental HIGHS were nearly normal in position, extent, and intensity. The pressure gradient between the 40th and 60th parallels, east of the 40th meridian, was slightly steeper than usual and the Icelandic LOW was indicated by an isobar of 29.6 inches.

The following table gives for a number of selected 5-degree squares the average pressure for each of the three decades of the month, as well as the highest and lowest individual readings reported during the month within the respective squares:

Pressure over the North Atlantic Ocean during September, 1917, by 5-degree squares.

Position of 5-degree squares.		Decade means.			Extremes.			
					Highest.		Lowest.	
Latitude.	Longitude.	I	II	III *	Pressure.	Date.	Pressure.	Date.
°	°	*Inches.*	*Inches*	*Inches*	*Inches.*	*September.*	*Inches.*	*September.*
60–65 N	20–25 W	29.77	29.40	29.50	30.12	4	29.15	17
60–65 N	0– 5 E	29.84	29.50	29.56	30.07	5	29.20	27
55–60 N	35–40 W	29.77	29.52	29.65	30.05	4	29.18	18
55–60 N	10–15 W	29.86	29.60	29.74	30.20	9	29.30	18
50–55 N	55–60 W	29.84	29.93	29.90	30.25	15	29.58	29
50–55 N	25–30 W	29.99	29.80	29.85	30.31	12	29.40	18
50–55 N	0– 5 W	30.00	29.95	30.14	30.34	29	29.70	1
45–50 N	65–70 W	30.02	30.18	30.00	30.52	15	29.60	28
45–50 N	40–45 W	30.01	29.95	29.92	30.30	12	29.60	20,27
45–50 N	10–15 W	30.10	30.13	30.16	30.50	12	29.75	18
40–45 N	50–55 W	30.02	30.06	29.99	30.33	24	29.70	19
40–45 N	25–30 W	30.28	30.20	30.14	30.53	12	29.76	18
35–40 N	75–80 W	30.10	30.14	30.07	30.30	12,23	29.68	30
35–40 N	35–40 W	30.24	30.20	30.14	30.51	23	29.88	18
35–40 N	10–15 W	30.16	30.14	30.17	30.30	7	30.00	10
30–35 N	50–55 W	30.17	30.14	30.12	30.36	24	29.96	10
30–35 N	25–30 W	30.25	30.16	30.19	30.40	8	29.96	18
25–30 N	90–95 W	30.04	29.94	29.90	30.08	9	29.70	28
25–30 N	60–65 W	30.01	30.04	30.07	30.20	24	29.80	4
25–30 N	15–20 W	30.09	30.05	30.12	30.20	6,21	30.00	8,15,18
15–20 N	35–40 W	30.02	30.00	30.03	30.12	23	29.95	15
10–15 N	80–85 W	29.91	29.88	29.91	29.96	21,26	29.80	15

* The mean values presented in the above table are based on the interpolated daily pressure for each square on the daily synoptic charts of the North Atlantic, compiled by the Marine Section of the Weather Bureau. The extremes are the highest and lowest actual readings observed within the respective squares.

GALES.

Over the northern steamer lanes winds of gale force were unusually rare, not being reported on more than one day in any 5-degree square. In the waters adjacent to the coasts of North and South Carolina gales were reported on 5 days, which is considerably above the normal, and they occurred on two days in the western part of the Gulf of Mexico, as well as off the southwest coast of Cuba. From the 1st to the 3d a slight depression covered the greater part of the northern steamer routes, and a few reports were received that denoted moderate gales in the central and western sections.

On the 4th there was a well-developed LOW (I on Chart IX) central near Bermuda, where the barometer reading was 29.46 inches. Light to moderate winds were the rule in that locality, although moderate gales prevailed near the 24th parallel and 84th meridian. LOW I moved rapidly northeastward, and on the 5th its center was near latitude 39°, longitude 55°; the barometer had risen slightly since the 4th, although the wind had increased to a marked extent, and one vessel in the southeast quadrant reported a southerly gale of over 60 miles an hour. The observer on this ship stated in the storm log that shortly after midnight on the 5th, when the storm was at its height, the barometer reading was 28.20 inches, and the wind blew with hurricane force from the east-northeast. The disturbance then diminished very rapidly in intensity, and at Greenwich mean noon on the 6th it had practically disappeared, light to moderate winds prevailing. From the 7th to the 11th no material depressions or heavy winds were reported.

On the 12th the center of a LOW of 29.82 inches was about 200 miles south of Jamaica, and at the same time a HIGH with a crest of 30.26 inches covered a portion of the American coast between Portland and Norfolk. A number of vessels off Hatteras encountered northeasterly gales of from 40 to 50 miles an hour, with accompanying barometric readings of from 30.06 to 30.17 inches.

On the 13th a LOW of considerable extent, and with rather indefinite limits, extended from the 10th to the 35th meridians, north of the 60th parallel, and vessels near latitude 58°, longitude 30° reported "straight" westerly gales of about 50 miles an hour. This disturbance was practically stationary from the 14th to the 19th, conditions of wind and weather within this region varying but little during the period.

On the 16th and 17th there was a slight depression off the coasts of Virginia and North Carolina, while on the same date a well-developed HIGH covered the greater part of eastern Canada. Moderate northeasterly gales prevailed along the coast between Hatteras and the Delaware Capes, while to the north and south of these limits light to moderate winds were the rule. The LOW drifted slowly northeastward, increasing slightly in intensity, and on the 18th the center was near latitude 41°, longitude 68°, and westerly winds of gale force were reported from a limited area in the southerly quadrants.

On the 23d a LOW (II on Chart IX) was central near the east coast of Cuba which, though of slight intensity at that time, afterwards developed into a tropical hurricane of considerable violence. LOW II moved due west, and on the morning of the 24th was near latitude 20°, longitude 60°. The winds in that locality were comparatively light, although over a limited area off Hatteras northeasterly gales of from 40 to 65 miles an hour were encountered. The LOW then curved toward the northwest, reaching the Isle of Pines on the 25th, the weather conditions being about the same as on the previous day. Northeasterly gales of somewhat diminished force still prevailed along the coast between Hatteras and New York, the maximum velocity being about 40 miles an hour. LOW II continued on its northwesterly course, and on the 26th the center was near latitude 25°, longitude 84°; it had increased considerably in intensity, and moderate southeasterly gales prevailed in the northeast quadrant at the time of observation, while one vessel at 2 p. m. September 26, near latitude 26°, longitude 85°, encountered easterly winds of over 60 miles an hour.

On the 26th there was also a LOW of limited area and marked intensity in the vicinity of latitude 44°, longitude 55°. Southwesterly hurricane winds of from 75 to 90 miles an hour were reported near the center, although the storm area was of small extent.

LOW II moved rapidly westward during the next 24 hours, and on the 27th covered the central portion of the Gulf of Mexico. Southeasterly winds of hurricane force were reported in the northeast quadrants, accompanied by torrential rains. The northern LOW of the 26th had practically disappeared, and the force of the wind diminished materially. On the 28th LOW II had reached its greatest force, with its center a short distance south of Mobile, and a minimum barometric reading of 29.18 inches. It was accompanied by northeast hurricane winds of over 90 miles an hour and heavy rains. It then diminished very rapidly in intensity, and on the 29th the center was near Pensacola, where the barometric reading was 29.62 inches, with light to moderate winds prevailing.

AIR TEMPERATURE.

The average monthly temperature of the air over the ocean did not differ greatly from the normal, although in a limited area off the Banks of Newfoundland it was from 2° to 5° warmer than usual, and in the northeast trade-wind regions the positive departures ranged from 1° to 3°.

The seasonal fall in temperature during the month was marked in northern waters, in some localities the mean for the last decade being from 2° to 3° below that of the first. The fluctuations in temperature from day to day were not large, and in the square that includes the east coast of Labrador, where they are usually the greatest, the thermometer readings ranged from 47° on the 24th to 55° on a number of days in the first part of the month.

The following table gives the temperature departures for the month at a number of Canadian and United States Weather Bureau stations on the Atlantic and Gulf coasts.

	°F.		°F.
St. Johns, N. F.	+1.5	Norfolk, Va.	−3.5
Sydney, C. B. I.	+1.3	Hatteras, N. C.	−3.3
Halifax, N. S.	−1.7	Charleston, S. C.	−2.8
Eastport, Me.	−1.0	Key West, Fla.	−0.9
Portland, Me.	−3.2	Tampa, Fla.	+1.3
Boston, Mass.	−2.5	Mobile, Ala.	+0.3
Nantucket, Mass.	−3.1	New Orleans, La.	+0.2
Block Island, R. I.	−3.1	Galveston, Tex.	0.0
New York, N. Y.	−3.5	Corpus Christi, Tex.	+1.4

WATER-SURFACE TEMPERATURE.

Off the Banks of Newfoundland the surface of the water was from 1° to 6° warmer than usual, while in the region between the 30th and 40th parallels and the 50th meridian and the American coast, the departures ranged from 0° to −6°. In the waters adjacent to the European coast small positive departures were the rule, and in the Gulf of Mexico they were slightly negative, while in the territory south of the 40th parallel, between the 10th and 50th meridians the departures were irregular, ranging from +2° to −2°.

The seasonal fall in temperature of the water was not as large as that of the air, although noticeable in northern waters, while the daily fluctuation was about the same for the two elements.

FOG.

Fog was unusually rare off the Banks of Newfoundland, being reported on 3 days only in that locality, while the normal percentage ranges from 30 to 35. It was observed on 3 days over the shoals of Nantucket, which was also below the normal, though only slightly so. It was somewhat more prevalent than usual over the eastern part of the steamer lanes, and it occurred on 2 days in the Azores, an exceptionally large number for that region.

Winds of 50 mis./hr. (22.4 m./sec.) or over during September, 1918.

Station.	Date.	Velocity.	Direction.
Buffalo, N. Y.	28	56	sw.
Oklahoma, Okla.	1	50	sw.
Salt Lake City, Utah.	3	50	n.

CONDENSED CLIMATOLOGICAL SUMMARY.

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by section, September, 1918.

Section.	Temperature.								Precipitation.					
			Monthly extremes.								Greatest monthly.		Least monthly.	
	Section average.	Departure from the normal.	Station.	Highest.	Date.	Station.	Lowest.	Date.	Section average.	Departure from the normal.	Station.	Amount.	Station.	Amount.
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	69.8	−5.0	Madison	97	2	2 stations	34	21†	4.28	+0.91	Talladega	7.87	Eufaula	0.99
Arizona	74.1	+1.7	Sentinel	112	1	2 stations	25	24	0.46	−0.56	Ideal Ranger station	1.76	7 stations	0.00
Arkansas	67.3	−6.2	Camden	104	15	Dodd City	29	21	4.58	+0.97	Alicia	10.10	Crossett	1.80
California	67.6	−0.9	Needles	110	12	2 stations	23	24†	3.37	+1.88	Downieville	7.65	9 stations	0.00
Colorado	55.6	−1.8	Lamar	99	1†	Fort Lewis	15	10	2.28	+0.93	Hawthorne	5.15	Eads	0.25
Florida	77.6	−1.8	6 stations	98	1†	Wausau	44	22	6.42	−0.70	Fort Pierce	14.22	Bonifay	1.85
Georgia	71.2	−3.6	5 stations	97	3†	2 stations	35	21†	3.17	−0.35	Glennville	8.41	Goat Rock	0.99
Hawaii (August)	75.1	+0.6	2 stations	95	7†	Volcano Observatory	52	18	7.41	+0.95	Honomu	5.78	2 stations	0.00
Idaho	59.5	+3.1	Glenn's Ferry	103	5	Stanley	16	6	1.47	+0.30	Bonanza	4.76	St. Maries	0.05
Illinois	60.0	−7.1	2 stations	87	1†	2 stations	29	27†	3.77	+0.20	Salem	7.10	Antioch	1.58
Indiana	59.1	−7.9	Rome	89	9	La Porte	27	22†	4.19	+1.16	Kokomo	7.10	Vevay	0.98
Iowa	58.6	−4.8	Little Sioux	92	13	Denison	21	21	1.87	−1.49	Keosauqua	4.62	Cumberland	0.48
Kansas	63.8	−5.0	La Crosse	102	1	Burr Oak	24	20	2.76	−0.17	Kansas City	7.29	Gove	0.58
Kentucky	62.8	−7.2	Earlington	92	10	2 stations	30	22	2.94	+0.18	London	7.13	Edmonton	1.26
Louisiana	73.7	−4.1	Angola	104	1	2 stations	37	21	2.74	−1.32	Avoca Island	5.60	Shreveport	0.36
Maryland-Delaware	63.3	−3.8	Frederick, Md.	88	5	Oakland, Md.	27	23	3.76	+0.50	Princess Anne, Md.	5.66	Grantsville, Md	1.96
Michigan	53.5	−6.6	Lapeer	88	8	Iron River	15	30	2.85	−0.08	Marquette	5.49	Bloomingdale	0.63
Minnesota	52.6	−5.7	2 stations	91	8	Winton	18	26	1.17	−1.82	Lake Crystal	3.25	Beardsley	T.
Mississippi	70.8	−5.0	Okolona	100	15	Duck Hill	33	21	3.19	−0.31	Hernando	7.00	Bay St. Louis	0.65
Missouri	62.3	−6.7	2 stations	96	1†	Bethany	29	21	4.73	+0.77	Columbia	9.69	St. Catherine	1.73
Montana	55.3	+0.1	Foster	98	22	Lindsay	10	19	1.65	+0.26	Red Lodge	5.56	Valentine	0.09
Nebraska	59.6	−3.8	Franklin	100	13	Callaway	13	20	1.67	−0.46	Hull	4.85	North Platte	0.38
Nevada	62.6	+1.5	Las Vegas	104	4	Potts	26	4	1.35	+0.59	Tuscarora	3.50	2 stations	0.04
New England	56.8	−2.8	No. Grosvenor, Conn.	91	1	Somerset, Vt.	23	24	6.87	+3.32	Rockport, Mass.	10.65	Nantucket, Mass.	2.06
New Jersey	62.2	−3.3	Bridgeton	90	5	2 stations	29	25†	3.84	0.00	Belvidere	6.00	Atlantic City	2.66
New Mexico	63.4	−0.3	Artesia	106	14	Senorita	22	25	0.98	−0.49	Des Moines	4.04	15 stations	0.00
New York	56.4	−4.9	Wappingers Falls	86	4	2 stations	24	11	5.31	+1.96	Cutchogue	10.63	West Point	2.39
North Carolina	65.8	−4.6	Rockingham	95	6	Jefferson	27	23	4.23	+0.48	Greenville	7.07	Wilmington	1.05
North Dakota	51.9	−4.5	Beach	93	22	2 stations	11	19†	0.40	−1.24	Larimore	1.43	2 stations	0.00
Ohio	58.4	−7.4	Portsmouth	89	4†	Delaware	27	22	3.75	+1.09	Toledo	7.78	Waverly	1.70
Oklahoma	68.3	−5.5	Enid	109	14	Oakwood	30	28	3.52	+0.55	Ardmore	9.04	Mutual	0.85
Oregon	63.0	+4.2	Williams	100	19	2 stations	21	24	1.21	−0.50	Ashland	3.90	2 stations	0.00
Pennsylvania	58.7	−5.1	Sadsburyville	88	5	3 stations	28	11†	3.97	+0.13	Edinboro	7.52	Elk Lick	1.82
Porto Rico	79.6	+0.7	Isabela	99	4†	Lares	57	27†	7.88	−0.21	Humacao	16.03	Mona Island	1.79
South Carolina	60.8	−4.3	Walterboro	96	18	Saluda	26	23	3.87	−0.12	Summerville	7.03	Aiken	1.53
South Dakota	56.5	−4.7	Hopewell	96	23	Jefferson	15	19	1.36	−0.86	Walters Ranch	4.86	2 stations	T.
Tennessee	65.0	−6.0	Loudon	95	16	Erasmus	27	22	3.73	+0.61	Trenton	7.16	Chattanooga	1.25
Texas	73.6	−3.4	Encinal	107	4	Lieb	34	20	2.29	−0.56	Gainesville	8.45	3 stations	0.00
Utah	60.8	+1.8	2 stations	103	3†	Black's Fork	19	18	1.47	+0.24	Silver Lake	3.54	2 stations	0.00
Virginia	63.4	−5.0	Diamond Springs	94	1	Burkes Garden	28	22	3.98	+0.46	Hopewell	9.04	Monterey	1.94
Washington	63.1	+5.0	2 stations	99	3†	2 stations	27	25	0.33	−1.51	La Center	1.16	4 stations	0.00
West Virginia	60.5	−5.7	Charleston	93	4	Spencer	24	23	2.92	−0.01	Marlinton	4.73	Dam 26, Ohio River	1.37
Wisconsin	53.4	−6.4	2 stations	88	1	Big St. Germain Dam	15	30	1.69	−2.10	Florence	3.03	Grantsburg	0.77
Wyoming	54.0	−0.7	Fort Laramie	97	23	2 stations	18	6†	2.21	+1.11	Kirtley	5.43	Bedford	0.84

† Other dates also.

DESCRIPTION OF TABLES AND CHARTS.

(*See* the REVIEW, January, 1918, p. 48.)

TABLE I.—*Climatological data for Weather Bureau Stations, September, 1918.*

Districts and stations.	Elevation of instruments.			Pressure.			Temperature of the air.												Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Precipitation.			Wind.						Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
	Barometer above sea level.	Thermometer above ground.	Anemometer above ground.	Station, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean max.+mean min.÷2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.						Total.	Departure from normal.	Days with .01 inch or more.	Total movement.	Prevailing direction.	Maximum velocity.										
																										Miles per hour.	Direction.	Date.							
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F*		°*F*	°*F.*		°*F*	°*F.*		°*F.*	°*F.*	%	*In.*	*In.*		*Miles*									*0–10*	*In.*	*In.*
New England.							58.3	−2.2											81	5.60	+2.4											6.4		
Eastport	76	67	85	29.94	30.02	−0.01	54.5	−0.7	71	2	61	37	11	48	20	51	49	86	4.65	+1.7	12	6,612	s.	38	se.	27	7	6	17	6.9		
Greenville	1,070	6		28.86	30.02		52.2		75	23	61	30	11	44	30				6.52			17												
Portland, Me.	103	82	117	29.93	30.05	.00	56.7	−2.9	77	1	64	39	11	49	25	53	50	81	5.58	+2.4	15	5,998	s.	36	ne.	26	7	10	13	6.2		
Concord	288	70	79	29.72	30.04	−.02	56.4	−2.7	82	4	67	32	23	46	34				6.96	+3.8	14	2,617	nw.	12	w.	27	7	11	12	6.2		
Burlington	404	11	48	29.57	30.01	−.05	54.7	−4.2	77	2	62	33	11	47	26				5.67	+2.3	19	6,578	s.	33	s.	3	4	6	20	7.5		
Northfield	876	12	60	29.10	30.05	−.01	52.4	−2.2	78	2	62	27	11	42	34	49	47	87	5.10	+2.3	17	4,663	s.	34	s.	5	0	6	24	8.9		
Boston	125	115	188	29.90	30.04	−.03	61.2	−1.5	81	5	69	45	11	54	26	56	52	75	9.19	+6.0	12	6,679	w.	28	w.	27	8	10	12	5.9		
Nantucket	12	14	90	30.03	30.04	−.04	62.2	−0.6	77	5	68	44	11	56	20	59	56	82	2.06	−0.7	8	10,574	ne.	42	se.	26	9	9	12	5.9		
Block Island	26	11	46	30.02	30.04	−.04	61.7	−2.4	77	6	67	49	27	56	18	59	57	85	3.31	+0.3	11	10,897	nw.	44	nw.	21	11	6	13	6.1		
Providence	160	215	251	29.86	30.04	−.03	60.6	−2.6	81	6	69	42	25	52	27	55	52	75	8.04	+4.9	11	8,043	nw.	35	nw.	21	6	16	8	6.0		
Hartford	159	122	140	29.87	30.04	−.03	60.1	−1.6	81	2	70	38	25	51	32	55	52	82	4.89	+1.4	13	4,718	s.	28	s.	28	8	13	9	5.4		
New Haven	106	117	155	29.94	30.05	−.02	61.0	−2.9	78	2	70	42	27	52	25	56	52	76	6.16	+2.4	12	6,277	n.	27	sw.	28	14	7	9	5.1		
Middle Atlantic States.							62.8	−3.5											75	3.49	+0.1											5.1		
Albany	97	102	115	29.93	30.03	−.04	59.0	−3.3	82	4	68	38	30	50	29	53	50	76	5.37	+2.2	16	4,848	s.	32	s.	3	5	10	15	6.6		
Binghamton	871	10	69	29.10	30.03	−.04	56.6	−3.4	80	2	66	35	11	47	34				4.90	+2.1	16	3,217	nw.	20	s.	5	7	8	15	6.5		
New York	314	414	454	29.71	30.04	−.04	62.8	−3.7	80	4	70	44	27	56	24	56	52	71	3.54	0.0	9	11,198	nw.	43	sw.	28	5	14	11	6.3		
Harrisburg	374	94	104	29.67	30.07	−.01	61.8	−3.1	84	5	71	42	30	53	28	55	50	71	2.92	+0.1	12	4,116	w.	21	nw.	27	12	7	11	5.2		
Philadelphia	117	123	190	29.92	30.05	−.03	65.1	−2.3	84	5	74	45	27	56	23	57	53	71	3.76	+0.4	12	6,626	nw.	26	nw.	20	11	9	10	5.1		
Reading	325	81	98	29.71	30.06		62.4		83	5	72	42	27	52	29	55	51	72	2.64	−1.0	11	4,414	se.	24	nw.	27	9	10	11	5.4		
Scranton	805	111	119	29.20	30.06	−.01	58.6	−3.6	83	4	68	38	30	49	30	53	50	80	4.59	+1.7	15	3,879	n.	21	sw.	28	7	8	15	6.3		
Atlantic City	52	37	48	29.99	30.05	−.02	65.4	−2.2	81	1	73	46	22	58	25	61	57	77	2.66	−0.4	10	5,055	nw.	20	e.	11	16	7	7	4.2		
Cape May	18	13	49	30.06	30.08		65.4		80	19	73	48	23	58	24				3.41	+0.4	12	5,991	n.	30	nw.	20	16	9	5	3.9		
Sandy Hook	22	10	57	30.03	30.05		64.2		80	17	70	47	27	58	23	58	55	75	3.22		9	11,151	nw.	49	nw.	30	11	11	8	4.9		
Trenton	190	159	183	29.84	30.04		62.6		83	5	72	42	27	53	27	56	52	75	3.20	−0.4	9	7,065	nw.	29	sw.	28	12	9	9	5.4		
Baltimore	123	100	113	29.93	30.06	−.02	65.0	−3.6	82	10	74	46	27	56	26	58	53	70	3.01	−0.8	11	4,294	nw.	20	nw.	20	13	8	9	5.0		
Washington	112	62	85	29.94	30.06	−.02	64.2	−3.9	87	5	75	42	23	54	30	57	54	77	2.79	−0.8	9	3,748	n.	23	nw.	27	14	8	8	4.3		
Lynchburg	681	153	188	29.33	30.07	−.01	64.3	−4.1	84	16	76	37	23	53	33	57	54	77	2.61	−1.0	7	3,628	n.	28	w.	5	14	8	8	4.8		
Norfolk	91	170	205	29.96	30.06	.00	69.1	−2.6	87	19	77	48	21	61	35	62	59	78	3.12	−0.9	7	7,508	ne.	40	w.	18	13	12	5	4.1		
Richmond	144	11	52	29.92	30.07	.00	65.6	−5.2	88	5	76	42	22	55	30	59	55	76	3.55	+0.1	10	4,347	se.	27	nw.	20	14	8	8	4.8		
Wytheville	2,293	49	55	27.72	30.08	+.01	59.1	−4.5	81	4	70	34	23	48	34	53	51	84	3.85	+0.6	12	2,604	w.	24	w.	18	17	6	7	3.9		
South Atlantic States.							70.2	−2.9											78	3.62	−1.0											4.7		
Asheville	2,255	70	84	27.76	30.09	+.02	61.3	−3.7	82	3	72	35	22	51	32	55	53	83	3.00	0.0	11	4,157	nw.	26	n.	20	10	10	10	5.5		
Charlotte	773	153	161	29.23	30.06	−.01	67.0	−3.7	90	4	77	43	23	57	28	60	56	74	5.83	+2.6	8	3,122	ne.	21	w.	18	13	10	7	4.5		
Hatteras	11	12	50	30.01	30.02	−.04	71.6	−3.1	84	19	77	55	22	66	22	67			2.41	−2.9	8	8,633	ne.	41	n.	21						
Manteo	12	4	46				69.0		88	17	78	45	24	60					3.42		7		ne.				16	6	8			
Raleigh	376	103	110	29.66	30.06	−.01	67.2	−3.4	88	5	77	43	22	57	26	60	57	76	5.21	+1.9	7	4,426	ne.	31	n.	20	11	11	8	4.5		
Wilmington	78	81	91	29.96	30.04	−.01	70.4	−2.7	88	18	79	48	22	62	31	64	62	81	1.50	−3.8	6	4,669	ne.	27	n.	20	13	10	7	4.3		
Charleston	48	11	92	29.98	30.03	−.01	73.2	−3.0	92	18	81	54	21	66	30	67	64	78	3.10	−2.4	8	7,047	ne.	35	w.	6	14	7	9	4.1		
Columbia, S. C	351	41	57	29.68	30.05	.00	70.4	−3.3	91	17	80	48	22	61	30	62	58	70	3.31	−0.1	6	4,187	ne.	19	n.	20	16	7	7	4.2		
Greenville, S. C	1,013	113	122	28.96	30.04		66.6		86	4	75	44	22	58	27	60	57	77	4.38		8	4,694	ne.	37	w.	5	15	8	7	4.0		
Augusta	180	62	77	29.84	30.03	−.02	71.7	−2.7	91	17	82	48	23	62	30	64	62	77	1.38	−2.3	5	3,256	ne.	20	e.	22	10	9	11	5.5		
Savannah	65	150	194	29.96	30.03	.00	73.6	−1.8	91	18	81	53	23	66	30	67	65	83	4.24	−1.3	9	6,144	ne.	31	nw.	20	15	5	10	5.1		
Jacksonville	43	200	245	29.96	30.00	.00	75.8	−1.5	91	18	83	56	22	69	22	70	68	83	6.17	−1.9	14	7,632	ne.	32	sw.	6	9	16	5	5.1		
Florida Peninsula.							80.5	−0.7											77	6.33	−1.6											5.2		
Key West	22	10	64	29.92	29.94	.00	82.6	+0.1	91	9	88	73	3	77	17	75	73	74	3.53	−3.3	11	5,429	ne.	30	sw.	28	14	9	7	4.6		
Miami	25	71	79	29.95	29.98		79.5	−2.0	89	8	85	69	14	74	16	75	73	81	10.06	+0.4	14	4,913	e.	34	e.	9	6	14	10	6.1		
Sand Key	23	39	72	29.90	29.93	−.01	81.7		89	12	85	71	30	78	12	76	73	74	3.57		11	7,313	e.	38	s.	27	17	7	6	4.1		
Tampa	35	79	92	29.94	29.97	.00	79.4	−0.3	93	1	88	65	22	71	21	71	69	77	5.39	−2.0	10	4,431	ne.	30	sw.	28	5	18	7	5.8		
East Gulf States.							71.8	−3.0											75	4.18	+0.3											4.8		
Atlanta	1,174	190	216	28.83	30.06	+.01	68.2	−3.9	86	16	77	43	21	60	23	61	57	74	3.57	0.0	10	5,869	se.	46	w.	19	12	5	13	5.2		
Macon	370	78	87	29.65	30.04	+.01	70.4	−2.5	90	18	80	47	21	60	30	63	59	74	2.17	−1.2	8	3,600	ne.	26	w.	5	10	10	10	5.4		
Thomasville	273	49	58	29.71	30.00	−.01	74.0	−2.8	92	2	84	52	22	64	30	66	63	76	3.44	−0.8	8	2,686	ne.	18	n.	20	12	9	9	5.1		
Pensacola	56	149	185	29.94	30.00	+.01	74.3	−3.6	87	13	81	52	21	68	19	68	65	77	3.30	−1.9	9	8,358	ne.	43	se.	28	14	8	8	4.4		
Anniston	741	9	57	29.27	30.06	+.03	68.0	−3.3	89	1	79	38	21	57	34				7.71	+4.2	12	2,776	se.	25	nw.	19	14	8	8	4.1		
Birmingham	700	11	48	29.30	30.05	+.02	70.0	−4.0	91	1	81	42	21	60	31	61	57	75	7.73	+4.2	12	3,740	n.	26	nw.	3	11	12	7	4.5		
Mobile	57	125	161	29.94	30.00	.00	74.3	−2.2	89	3	82	51	21	66	25	67	64	77	5.17	+0.2	9	6,431	n.	34	n.	20	12	9	9	4.8		
Montgomery	223	100	112	29.79	30.04	+.02	71.6	−4.2	90	1	81	46	21	62	28	64	61	76	2.66	−0.2	8	3,909	e.	33	sw.	19	10	10	10	5.4		
Corinth	469	6																																
Jackson	304	5																																
Meridian	375	85	93	29.63	30.02	.00	70.8	−1.9	92	2	82	46	22	60	33	62	58	71	4.13	+0.7	7	3,165	ne.	35	nw.	19	13	9	8	4.3		
Vicksburg	247	65	74	29.78	30.05	+.03	71.3	−3.5	93	2	81	45	21	61	28	63	59	72	1.26	−2.1	8	4,254	n.	19	ne.	20	12	8	10	4.7		
New Orleans	51	76	84	29.94	29.99	+.01	76.9	−1.1	94	1	84	55	21	70	19	69	66	76	4.82	0.0	5	4,502	ne.	22	ne.	20	12	11	7	4.8		
West Gulf States.							72.8	−2.6											67	2.58	−0.9											3.6		
Shreveport	249	77	93	29.77	30.04	+.04	72.2	−3.5	97	14	83	46	21	61	34	62	58	68	0.36	−2.9	7	4,715	ne.	30	w.	4	20	5	5	3.4		
Bentonville	1,303	11	44	28.70	30.06	+.04	62.8	−6.1	89	14	75	35	21	51	37				4.47	+1.0	10	2,920	n.	18	s.	1	18	4	8	3.8		
Fort Smith	457	79	94	29.57	30.04	+.03	68.6	−0.3	95	14	80	45	2	58	34	60	55	70	4.02	+0.8	7	4,759	e.	43	sw.	19	17	2	11	4.2		
Little Rock	357	139	147	29.68	30.06	+.03	69.0	−4.1	95	15	78	48	21	60	30	59	53	63	4.63	+1.4	5	5,609	e.	28	se.	2	13	4	13	4.8		
Brownsville	57	4	26				80.8		102	5	93	52	29	68	42				0.97		4		se.											
Corpus Christi	20	69	77	29.98	30.01	+.06	77.9	−1.1	91	14	85	61	29	71	22	70	67	75	4.33	+0.3	6	7,687	se.	44	n.	26	24	3	3	2.2		
Dallas	512	109	117	29.49	30.03		72.6		100	14	84	47	21	62	34				4.28		5	5,521	se.	32	nw.	25	17	7	6	3.5		
Fort Worth	670	106	114	29.30	30.01	+.02	73.0	−3.7	101	14	84	48	21	62	36	61	54	61	2.09	−0.9	5	6,758	se.	34	s.	25	16	8	6	3.6		
Galveston	54	106	114	29.96	30.02	+.04	77.0	−2.4	90	12	82	58	28	72	17	69	65	70	2.03	−3.4	4	7,549	s.	28	n.	27	16	7	7	4.0		
Houston	138	111	121	29.88	30.02		76.4	−2.1	97	14	86	53	22	66	28				2.62		4	5,012	se.	25	se.	19	14	14	2	3.3		
Palestine	510	64	72	29.50	30.03	+.04	72.8	−1.9	98	14	83	48	21	62	32	63	59	71	1.63	−1.6	6	4,872	ne.	23	ne.	20	17	5	8	4.1		
Port Arthur	304	58	66	29.96	30.00		74.2		92	13	82	50	21	66	27	67	64	76	5.21		6	6,007	e.	29	ne.	26	15	10	5	3.4		
San Antonio	701	119	132	29.28	30.00	+.04	76.4	−0.7	99	13	88	53	22	65	34	64	57	60	1.49	−1.4	6	5,715	s.	30	n.	4	20	9	1	2.4		
Taylor	582	55	63	29.44	30.05	+.08	74.6	−2.3	99	14	87	48	21	62	37				0.80	−2.2	4	5,899	n.	29	se.	25	14	10	6	4.0		

TABLE I.—*Climatological data for Weather Bureau Stations, September, 1918*—Continued.

Districts and stations.	Elevation of instruments.			Pressure.			Temperature of the air.										Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Precipitation.			Wind.						Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
	Barometer above sea level.	Thermometer above ground.	Anemometer above ground.	Station, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean max.+m min.÷2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.					Total.	Departure from normal.	Days with .01 inch or more.	Total movement.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.							
Ohio Valley and Tennessee.	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F*	°*F*	°*F.*	°*F.*	°*F*	°*F.*	°*F.*		°*F.*	°*F.*	*In.*	*In.*	*Miles*									*0–10*	*In.*	*In.*
							62.1	**−5.8**											**74**	**2.96**	**+0.2**									**5.3**		
Chattanooga	762	189	213	29.26	30.07	+ .01	67.4	−3.8	90	16	77	45	23	57	29		59	54	71	1.25	−2.0	10	4,193	ne.	30	nw.	19	11	7	12	5.2		
Knoxville	996	102	111	29.01	30.06	.00	65.2	−4.2	87	16	75	39	22	55	27		58	55	77	1.59	−1.2	11	2,940	ne.	24	s.	12	11	10	9	5.3		
Memphis	399	76	97	29.67	30.09	+ .06	67.6	−5.2	90	15	76	45	21	59	29		60	56	72	4.95	+1.9	9	4,935	n.	38	nw.	19	15	5	10	4.5		
Nashville	546	168	191	29.50	30.09	+ .03	65.4	−6.1	87	3	76	41	21	55	33		57	51	67	3.75	+0.1	8	5,492	ne.	28	nw.	16	14	7	9	4.6		
Lexington	989	193	230	29.02	30.08	+ .01	62.4	−5.5	84	2	72	40	27	53	26					1.41	−1.0	10	7,516	se.	33	nw.	19	12	11	7	4.5		
Louisville	525	219	255	29.52	30.10	+ .04	62.7	−7.2	83	9	73	42	†22	53	31		55	50	70	2.19	−0.4	9	6,418	n.	36	w.	12	13	7	10	4.7		
Evansville	431	139	175	29.62	30.09	+ .03	63.5	−6.2	83	9	73	42	27	54	28		56	51	70	3.33	+0.7	11	6,363	ne.	29	w.	18	10	11	9	5.1		
Indianapolis	822	194	230	29.20	30.08	+ .02	59.8	−6.9	80	1	69	39	20	51	27		52	48	70	5.14	+2.1	10	6,597	sw.	34	w.	18	8	14	8	5.4		
Terre Haute	575	96	129	29.45	30.07		60.2		81	9	70	38	20	50	32		53	49	74	5.04		8	5,315	s.	26	w.	18	7	16	7	5.5		
Cincinnati	628	11	51	29.40	30.08	+ .01	59.9	−4.8	82	2	71	34	22	49	31		53	50	76	2.70	+0.4	11	3,867	n.	25	n.	30	10	11	9	5.2		
Columbus	824	173	222	29.21	30.08	+ .01	59.0	−6.9	80	4	68	38	22	50	28		53	50	76	3.19	+0.7	10	6,529	nw.	31	w.	12	9	9	12	5.7		
Dayton	899	181	216	29.10	30.06		59.1	−8.3	80	9	68	38	22	50	26		53	50	78	4.13	+1.6	9	5,411	sw.	29	w.	12	10	9	11	5.4		
Pittsburgh	842	353	410	29.16	30.07	− .01	59.8	−6.3	81	4	68	39	22	52	23		53	49	73	2.22	−0.3	13	6,666	nw.	30	w.	12	8	4	18	6.4		
Elkins	1,940	41	50	28.05	30.10	+ .02	56.6	−5.3	84	4	68	29	27	45	39		50	48	86	3.06	+0.2	12	2,667	nw.	24	w.	16	5	13	12	6.5		
Parkersburg	638	77	84	29.44	30.09	+ .01	61.0	−5.1	86	4	72	35	22	50	34		55	52	80	2.53	−0.2	11	3,195	se.	17	nw.	21	12	10	8	5.2		
Lower Lake Region.							**56.8**	**−6.3**											**74**	**4.74**	**+1.9**									**6.5**		
Buffalo	767	247	280	29.20	30.03	−0.03	56.0	−6.9	79	2	63	37	26	49	27		51	47	76	3.79	+0.6	20	11,487	w.	56	sw.	28	3	6	21	7.5		
Canton	448	10	61	29.50	29.98		54.4	−4.9	81	2	63	30	11	46	30					6.05	+3.2	19	6,481	sw.	40	sw.	28	6	8	16	6.9		
Oswego	335	76	91	29.65	30.02	− .04	56.0	−6.7	80	2	63	36	27	49	27		52	48	77	3.79	+1.0	16	6,939	s.	35	ne.	10	1	14	15	7.1		
Rochester	523	97	113	29.47	30.04	− .02	56.6	−5.3	84	2	64	39	26	49	30		51	47	74	4.01	+1.7	18	5,401	sw.	28	sw.	28	3	10	17	7.1		
Syracuse	597	97	113	29.38	30.02	− .05	56.2	−5.4	79	2	64	36	27	49	31					4.34	+1.5	19	7,437	s.	38	sw.	5	3	15	12	6.7		
Erie	714	130	166	29.27	30.04	− .02	57.5	−6.4	81	2	64	42	30	51	26		52	48	74	5.49	+2.0	19	9,047	s.	40	sw.	18	3	11	16	7.0		
Cleveland	762	190	201	29.24	30.07	+ .01	58.2	−6.1	81	2	65	43	22	52	22		52	48	72	3.78	+0.6	15	9,066	sw.	45	w.	18	8	8	14	6.4		
Sandusky	629	62	103	29.38	30.06	.00	58.4	−6.9	82	2	66	39	22	50	27					4.30	+1.6	10	8,222	sw.	38	n.	5	7	9	14	6.3		
Toledo	628	208	243	29.39	30.08	+ .02	57.6	−6.5	79	9	66	38	20	49	26		51	47	72	7.78	+5.4	12	9,147	sw.	49	ne.	4	12	6	12	5.4		
Fort Wayne	856	113	124	29.16	30.09		57.1	−8.4	80	1	66	36	22	48	28		51	47	75	6.19		8	5,400	sw.	33	sw.	18	9	11	10	5.4		
Detroit	730	218	245	29.27	30.07	+ .01	57.4	−5.7	80	9	66	38	27	49	27		51	47	74	4.10	+1.6	13	7,833	w.	36	ne.	5	4	15	11	6.2		
Upper Lake Region.							**53.3**	**−5.7**											**72**	**2.65**	**−0.6**									**5.9**		
Alpena	609	13	92	29.37	30.03	.00	52.0	−5.3	80	9	61	30	30	43	36		47	43	76	2.18	−1.3	10	7,673	nw.	46	se.	11	3	15	12	6.7	T.	
Escanaba	612	54	60	29.38	30.05	+ .04	50.6	−6.3	72	27	60	29	30	41	38		47	44	84	2.44	−1.1	10	6,574	n.	32	n.	25	9	14	7	4.7	T.	
Grand Haven	632	54	92	29.37	30.06	+ .02	55.2	−5.9	75	2	62	36	27	48	26		51	48	76	2.61	−0.6	13	7,673	nw.	38	w.	18	8	14	8	5.4		
Grand Rapids	707	70	87	29.29	30.06	+ .01	56.2	−5.6	79	1	65	38	26	47	28		50	45	72	2.01	−1.1	11	3,871	nw.	25	w.	18	8	10	12	5.9		
Houghton	684	62	99	29.30	30.03	+ .03	49.6	−6.5	69	8	56	34	30	43	29					3.87	+0.3	14	6,455	w.	37	nw.	27	5	16	9	5.7	T.	
Lansing	878	11	62	29.11	30.07		54.2		79	1	65	34	27	43	32		49	46	82	2.88	+0.3	13	3,478	sw.	18	sw.	18	5	12	13	6.4		
Ludington	637	60	66	29.35	30.05		53.8		72	2	60	37	30	48	21		50	47	77	3.09		13	6,785	n.	30	sw.	27	13	6	11	5.4		
Marquette	734	77	111	29.26	30.08	+ .08	49.3	−7.5	75	8	56	32	30	42	37		46	44	84	5.49	+2.0	15	7,199	w.	29	nw.	18	4	14	12	6.7		
Port Huron	638	70	120	29.34	30.04	− .02	54.8	−6.1	79	9	63	37	22	47	28		50	46	77	4.78	+2.1	13	7,659	nw.	42	ne.	5	4	17	9	5.8		
Saginaw	641	48	82	29.35	30.05		54.9		79	1	65	33	26	45	30		49	45	76	2.06	−1.0	15	5,983	nw.	27	s.	18	4	14	12	6.1		
Sault Ste. Marie	614	11	61	29.33	30.03	+ .01	49.6	−4.7	69	2	58	34	30	42	30		46	44	87	2.68	−0.8	16	6,111	nw.	35	w.	15	7	6	17	7.1	0.2	
Chicago	823	140	310	29.19	30.08	+ .04	59.6	−5.0	82	1	66	40	20	53	24		53	48	69	1.84	−1.2	7	7,481	sw.	31	sw.	18	9	11	10	5.4		
Green Bay	617	109	144	29.38	30.04	+ .02	54.2	−4.9	84	1	63	35	30	45	38		48	44	73	1.71	−1.4	7	7,192	sw.	31	nw.	19	5	13	12	6.6		
Milwaukee	681	119	133	29.32	30.06	+ .03	57.5	−4.0	83	1	65	40	26	50	29		50	46	71	1.15	−1.8	8	6,873	w.	25	ne.	9	12	8	10	5.4		
Duluth	1,133	11	47	28.85	30.08	+ .10	50.4	−6.3	74	27	60	30	30	41	28		44	40	76	1.41	−2.1	10	8,671	nw.	39	nw.	9	13	7	10	4.9		
North Dakota							**52.3**	**−4.9**											**68**	**0.38**	**−1.0**									**42**		
Moorhead	940	8	57	29.11	30.14	+ .18	52.2	−4.4	80	8	66	22	20	39	43		44	40	76	0.29	−2.0	7	5,074	n.	30	nw.	8	19	7	4	2.9		
Bismarck	1,674	8	57	28.35	30.15	+ .21	53.9	−3.2	87	22	68	26	20	40	46		45	38	64	0.47	−0.7	5	6,093	nw.	36	e.	23	15	7	8	4.3		
Devils Lake	1,482	11	44	28.57	30.11	+ .17	50.4	−5.2	79	7	64	27	9	37	40		42	36	67	0.48	−0.9	6	6,418	nw.	36	n.	8	9	15	6	5.3		
Ellendale	1,457	10	56	28.54	30.12		52.5		83	12	67	21	20	38	47		44	37	65	0.14		2	9,183	nw.	44	e.	23	13	9	8	4.8		
Grand Forks	835	12	80				50.7		79	8	64	23	20	37	46		45			0.46		8		nw.	38	w.	26	19	9	2			
Williston	1,872	41	48	28.11	30.10	+ .17	52.8	−6.7	84	7	66	22	19	40	41		45	38	63	0.30	−0.6	3	5,190	n.	42	e.	23	11	15	4	4.4		
Upper Mississippi Valley.							**58.9**	**−5.9**											**73**	**2.77**	**−0.6**									**50**		
Minneapolis	918	10	208	29.08	30.06		55.1		81	8	64	36	19	46	31					1.25	−2.4	5	7,103	nw.	40	n.	9	7	13	10	5.8		
St. Paul	837	201	236	29.17	30.08	+ .09	54.6	−5.7	79	1	64	34	21	45	32					1.19	−1.9	8	7,208	nw.	38	s.	8	9	17	4	4.6		
La Crosse	714	11	48	29.30	30.07	+ .06	54.8	−6.9	80	8	66	32	21	44	43					1.36	−2.8	11	2,667	nw.	13	s.	22	9	11	10	5.6		
Madison	974	70	78	29.04	30.09	+ .06	55.9	−5.2	82	1	65	38	26	47	30	50	45	74		1.52	−1.7	7	6,038	nw.	27	nw.	18	7	12	11	6.0		
Wausau	1,247	4	....	28.71	30.04		51.2		81	1	62	28	30	41	38					1.58		10		nw.			10	12	8	5.1		
Charles City	1,015	10	49	29.01	30.10	+ .10	55.3	−6.4	85	1	67	31	21	44	38	48	45	79		4.07	+1.3	6	3,480	nw.	19	nw.	17	10	13	7	4.9		
Davenport	606	71	79	29.42	30.09	+ .06	58.9	−5.8	82	1	69	35	20	49	31	52	48	74		2.19	−1.0	6	4,540	sw.	20	nw.	11	12	7	11	5.1		
Des Moines	861	84	97	29.17	30.08	+ .06	60.2	−4.8	85	1	71	34	20	49	41	51	44	63		0.91	−2.2	7	4,892	n.	34	sw.	17	14	8	8	4.5		
Dubuque	698	81	96	29.35	30.11	+ .08	57.4	−6.2	81	1	67	36	27	48	37	50	45	72		1.63	−2.0	9	3,927	nw.	21	nw.	18	9	13	8	5.6		
Keokuk	614	64	78	29.42	30.09	+ .06	61.3	−5.1	83	1	71	37	20	52	31	53	48	69		1.77	−2.2	9	4,653	s.	19	nw.	18	15	10	5	3.8		
Cairo	356	87	93	29.68	30.06	+ .01	64.1	−6.1	84	14	73	41	21	55	26	57	53	74		5.29	+2.8	9	5,038	n.	25	n.	19	12	4	14	5.2		
Peoria	609	11	45	29.44	30.09	+ .05	58.2	−6.1	82	1	69	33	20	47	37	52	49	81		1.67	−1.4	7	3,573	s.	18	sw.	14	13	8	9	4.8		
Springfield, Ill	644	10	91	29.40	30.08	+ .03	60.4	−6.0	81	9	70	37	20	51	34	53	50	76		4.71	+1.3	9	4,722	s.	24	nw.	11	11	9	10	5.3	T	
Hannibal	534	74	109	29.80	30.07	+ .04	61.2	−6.7	83	14	71	38	20	51	35					5.89	+2.3	10	5,189	sw.	27	sw.	14	14	7	9	4.7		
St. Louis	567	265	303	29.47	30.07	+ .03	63.6	−6.4	82	10	72	42	20	56	28	55	50	67		5.09	+2.2	9	7,382	s.	40	sw.	4	15	10	5	3.8		
Missouri Valley.							**60.8**	**−4.5**											**64**	**3.08**	**+0.4**									**4.3**		
Columbia, Mo.	781	11	84	29.24	30.08	+ .05	61.4	−6.4	84	1	72	36	20	51	40					9.69	+6.8	9	4,545	se.	21	n.	4	14	10	6	4.5		
Kansas City	963	161	181	29.05	30.08	+ .06	63.8	−3.7	87	13	73	40	20	54	31	54	47	62		7.29	+3.5	11	7,488	n.	35	w.	1	19	5	6	3.5		
St. Joseph	967	11	49	29.04	30.08		62.8		88	13	74	34	21	52	35	53	47	65		4.53		10	4,755	s.	21	nw.	25	17	7	6	3.3		
Springfield, Mo.	1,324	98	104	28.67	30.08	+ .05	62.8	−5.1	89	14	72	39	20	53	27	55	50	71		4.82	+1.1	8	6,311	se.	31	s.	2	14	8	8	3.9		
Iola	984	11	50	29.03	30.06	+ .05	63.8	−4.8	91	14	76	35	21	51	43					3.51	+0.2	9	4,540	n.	25	n.	15	12	13	5	4.5		
Topeka	983	85	101				63.2	−5.1	93	13	75	36	20	52	36					4.05	+0.5	7	6,594	se.	42	w.	1	15	10	5	3.6		
Drexel	1,299	10	54	28.68	30.08		60.7		92	18	74	30	20	48	39	50	42	62		1.04		10	6,940	ne.	35	sw.	17	14	8	8	4.1		
Lincoln	1,189	11	84	28.81	30.06	+ .07	62.1	−3.1	93	13	74	31	20	50	39	51	43	59		2.25	−0.4	8	6,457	ne.	33	sw.	17	12	10	8	4.6		
Omaha	1,105	115	122	28.90	30.08	+ .08	62.4	−3.4	93	13	73	35	20	52	33	51	42	56		1.03	−2.0	9	5,512	n.	26	n.	29	14	9	7	4.6		
Valentine	2,598	47	54	27.39	30.10	+ .14	57.4	−4.9	89	8	71	26	20	42	45	48	42	67		1.89	+0.1	8	5,904	n.	35	ne.	8	11	10	9	5.1		
Sioux City	1,135	94	164	28.88	30.09	+ .11	59.0	−5.1	85	8	71	29	20	47	42	50	45	67		0.52	−2.0	8	5,629	n.	34	nw.	11	14	6	10	4.5		
Huron	1,306	59	74	28.72	30.13	+ .17	55.6	−4.0	89	8	69	24	20	42	47	46	40	65		0.28	−1.4	3	6,196	se.	36	n.	8	12	11	7	4.8		
Pierre	1,572	70	75	28.44	30.10	+ .15	58.9	−3.9	89	12	71	30	19	47	44	49	43	64		0.64	−0.5	6	5,363	e.	32	n.	8	15	6	9	4.6		
Yankton	1,233	49	57	28.76	30.08	+ .10	58.8	−4.5	87	8	70	28	20	47	38					1.03	−1.4	6	4,318	n.	24	s.	8	12	7	11	5.1	T.	

† Other dates also.

TABLE I.—*Climatological data for Weather Bureau Stations, September, 1918*—Continued.

Districts and stations.	Elevation of instruments.			Pressure.			Temperature of the air.										Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Precipitation.			Wind.						Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
	Barometer above sea level.	Thermometer above ground.	Anemometer above ground.	Station, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean max.+mean min.÷2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.					Total.	Departure from normal.	Days with .01 inch or more.	Total movement.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.						
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F*		°*F*	°*F.*		°*F*	°*F.*		°*F.*	°*F.*	%	*In.*	*In.*		*Miles.*								*0–10*	*In.*	*In.*
Northern Slope.							**55.8**	**−1.6**											**66**	**1.37**	**+0.4**										**4.9**		
Billings	3,140	5					57.1		88	7	71	33	4	43	49					2.21		11		ne.				15	6	9			
Havre	2,505	11	44	27.47	30.11	+ .20	55.2	−2.4	84	11	70	30	15	40	46		48	42	69	0.98	0.0	5	3,578	ne.	25	n.	7	12	10	8	4.9		
Helena	4,110	87	114	25.92	30.10	+ .13	56.0	−0.2	82	20	68	37	16	44	39		46	39	61	1.76	+0.7	11	4,808	sw.	24	sw.	17	13	4	13	5.0		
Kalispell	2,962	11	34	27.02	30.06	+ .10	56.8	+2.9	80	12	70	35	3	43	38		47	40	61	1.59	+0.3	4	3,571	nw.	26	ne.	1	17	6	7	3.9		
Miles City	2,371	26	48	27.59	30.14	+ .19	58.9	−2.3	94	22	70	36	15	47	40		51	46	73	0.75	−0.2	7	3,536	n.	20	n.	1	14	9	7	4.3		
Rapid City	3,259	50	58	26.73	30.14	+ .21	56.7	−2.4	88	22	67	30	20	46	44		47	39	58	2.06	+0.8	13	5,894	w.	36	n.	8	15	6	9	4.8		
Cheyenne	6,088	84	101	24.13	30.07	+ .11	53.1	−4.1	81	1	64	32	15	42	35		45	40	71	2.57	+1.6	12	7,339	w.	44	w.	23	9	8	13	6.4	1.2	
Lander	5,372	60	68	24.77	30.08	+ .12	56.0	+0.8	85	1	70	36	5	42	43		46	38	59	1.03	0.0	8	2,787	sw.	30	w.	1	11	10	9	5.2		
Sheridan	3,790	10	47	26.22	30.12		55.0		88	22	68	31	16	42	50		47	43	74	2.68		14	3,195	nw.	26	sw.	22	11	6	13	5.4		
Yellowstone Park	6,200	11	48		30.10	+ .13	50.6	−2.8	79	21	64	29	16	38	39				63	2.11	+1.1	11	4,777	nw.	31	nw.	2	12	9	9			
North Platte	2,821	11	51	27.19	30.11	+ .14	58.9	−4.3	90	13	73	25	20	44	43		48	42	66	0.38	−1.1	5	4,653	n.	26	ne.	14	14	8	8	4.3		
Middle Slope.							**63.2**	**−4.4**											**65**	**2.39**	**+0.4**										**4.1**		
Denver	5,292	106	113	24.85	30.08	+ .12	58.0	−4.7	86	14	69	33	15	47	37		50	45	69	2.89	+2.0	12	4,632	s.	28	n.	23	11	10	9	5.2	T.	
Pueblo	4,685	80	86	25.40	30.06	+ .10	60.8	−3.6	92	14	73	37	20	48	45		50	43	62	1.43	+0.8	8	3,889	se.	33	nw.	24	13	6	11	5.0		
Concordia	1,392	50	58	28.61	30.08	+ .09	63.2	−4.9	96	13	75	33	26	51	36		52	45	63	1.72	−0.9	9	5,830	s.	26	w.	24	12	12	6	4.4		
Dodge City	2,509	11	51	27.48	30.07	+ .14	63.4	−4.8	99	1	76	38	20	50	41		52	47	67	2.20	+0.4	7	5,103	ne.	30	se.	23	17	8	5	3.4		
Wichita	1,358	139	158	28.62	30.04	+ .04	65.4	−4.4	93	14	77	36	20	54	33		56	49	64	1.80	−1.3	7	8,841	s.	39	s.	1	16	9	5	3.6		
Altus	1,410	5					71.1		104	14	84	43	21	58	41					2.48		4		n.				17	2	11			
Muskogee	652	4					67.8		97	14	80	39	21	55	37					7.34		8						11	0	19			
Oklahoma	1,214	10	47	28.77	30.04	+ .05	68.0	−4.1	97	14	80	41	21	56	38		57	52	65	4.28	+1.5	9	8,288	s.	50	sw.	1	16	6	8	3.9		
Southern Slope.							**70.5**	**−2.3**											**59**	**0.95**	**−1.8**										**3.3**		
Abilene	1,738	10	52	28.23	30.01	+ .05	72.2	−2.0	100	14	85	42	28	60	40		58	48	52	0.76	−2.4	7	6,884	s.	30	s.	24	17	5	8	3.7		
Amarillo	3,676	10	49	26.36	30.05	+ .01	65.4	−2.3	99	14	78	37	20	52	37		54	47	63	0.64	−1.7	7	8,176	s.	31	sw.	1	17	6	7	3.9		
Del Rio	944	64	71	29.01	29.99	+ .05	76.8	−2.1	100	4	88	52	29	66	38					1.23	−1.3	5	6,001	se.	36	ne.	4	20	8	2	2.2		
Roswell	3,566	75	85	26.42	29.98	+ .06	67.6	−2.7	98	14	81	46	21	54	40		57	51	62	1.16	−1.1	5	5,396	s.	33	nw.	18	16	11	3	3.3		
Southern Plateau.							**71.0**	**+0.5**											**48**	**0.52**	**−0.5**										**2.4**		
El Paso	3,762	110	133	26.22	29.90	+ .02	73.6	+0.9	98	14	86	48	29	62	35		57	46	44	0.01	−1.4	1	7,607	se.	35	e.	16	23	5	2	2.2		
Santa Fe	7,013	57	66	23.36	29.96	+ .03	60.4	−0.2	82	14	72	38	17	49	34		48	40	57	0.76	−0.9	5	4,752	e.	33	sw.	9	14	15	1	4.0		
Flagstaff	6,908	8	57	23.44	29.92	+ .03	56.7	+1.2	81	12	73	25	24	40	45		45			1.04		6		nw.	44	sw.	23	19	11	0	2.6		
Phoenix	1,108	76	81	28.69	29.81	.00	82.4	+1.0	104	11	98	55	26	67	41		66	58	51	0.39	−0.6	2	3,406	e.	23	e.	27	26	4	0	1.1		
Yuma	141	9	54	29.64	29.78	.00	84.6	+0.7	107	12	100	59	24	69	41		69	62	50	0.02	−0.1	1	3,031	w.	18	s.	19	25	5	0	1.6		
Independence	3,910	11	42	25.96	29.94	+ .08	68.4	−0.7	91	1	83	47	25	54	36		51	35	37	0.40	+0.3	5	3,986	nw.	30	se.	13	21	4	5	2.8		
Needles	488	4		29.29	29.78		84.4		110	12	103	54	24	66	45					0.08		1						18	4	8			
Middle Plateau.							**63.5**	**+1.2**											**46**	**1.48**	**+0.8**										**3.9**		
Reno	4,532	74	81	25.48	29.92	−.03	62.1	+2.4	88	19	76	37	24	48	41		49	39	52	2.41	+2.1	11	3,871	w.	40	sw.	6	13	10	7	4.4		
Tonopah	6,090	12	20	24.10	29.92	−.03	63.4		81	1	73	39	23	54	25		47	33	36	0.65	+0.2	4	6,256	se.	33	se.	13	19	8	3	2.8		
Winnemucca	4,344	18	56	25.64	29.99	+.06	61.6	+1.1	90	1	77	34	24	46	46		49	39	55	1.53	+1.2	8	3,865	ne.	22	nw.	21	13	8	9	4.8		
Modena	5,479	10	43	24.67	29.95	+.03	60.8	+0.6	85	20	77	35	24	44	43		47	34	45	1.22	+0.1	6	6,720	w.	44	sw.	7	15	7	8	3.7		
Salt Lake City	4,360	163	203	25.65	29.96	+.01	66.6	+1.5	89	13	78	46	25	56	33		52	41	44	2.10	+1.2	9	5,209	se.	50	n.	3	16	7	7	4.1		
Grand Junction	4,602	82	96	25.44	29.98	+.03	66.6	+0.2	91	14	80	45	24	54	35		51	40	46	0.97	0.0	6	4,399	se.	45	nw.	23	16	11	3	3.6		
Northern Plateau.							**64.6**	**+3.4**											**53**	**0.35**	**−0.1**										**4.1**		
Baker	3,471	48	53	26.47	30.03	+.04	59.9	+2.9	87	19	74	37	26	46	44		50	42	59	0.53	−0.2	5	4,200	se.	19	sw.	29	16	4	10	4.2		
Boise	2,739	78	86	27.18	30.00	+.03	65.2	+3.3	91	20	77	43	24	53	38		54	45	55	2.32	+1.9	7	2,799	nw.	18	nw.	29	15	6	9	4.3		
Lewiston	757	40	48	29.19	29.99	+.01	67.2	+3.7	94	28	83	43	26	52	45					0.37	−0.3	4	1,442	e.	19	n.	1	15	5	10	4.3		
Pocatello	4,477	60	68	25.52	30.00	+.04	61.9	+1.2	87	21	76	39	16	48	37		49	38	51	0.33	−0.6	7	5,007	se.	40	s.	22	12	13	5	4.4		
Spokane	1,929	101	110	27.99	30.01	+.03	64.8	+6.0	89	19	78	37	25	51	40		53	43	52	0.24	−0.8	2	3,013	ne.	25	ne.	1	15	8	7	3.9		
Walla Walla	991	57	65	28.92	29.98	−.02	68.8	+3.4	92	18	82	48	24	56	36		56	45	47	0.32	−0.6	4	2,437	s.	26	s.	29	19	4	7	3.4		
North Pacific Coast Region.							**61.4**	**+3.8**											**74**	**0.29**	**−2.1**										**4.9**		
North Head	211	11	56	29.80	30.02	−.01	56.2	.00	83	27	61	47	18	52	33		54	52	92	T.	−1.8	0	7,311	n.	32	n.	17	7	7	16	6.5		
North Yakima	1,071	4					67.4		92	28	84	40	26	51	47					0.34		4		nw.				23	5	2			
Port Angeles	29	8	53	30.03	30.06		57.2		82	14	68	40	24	46	32					0.10	−1.7	1	3,098	s.	14	nw.	20	12	7	11	4.7		
Seattle	125	215	250	29.91	30.04	+.03	62.2	+4.3	82	5	71	47	21	53	28		56	50	69	0.08	−1.8	1	3,704	n.	23	n.	2	13	9	8	4.8		
Tacoma	213	113	120	29.80	30.02	.00	62.0	+4.4	83	28	72	43	25	52	30		55	50	69	0.45	−2.0	1	2,755	n.	21	n.	27	6	11	13	6.2		
Tatoosh Island	109	7	57	29.94	30.03	+.02	54.0	+1.0	74	2	59	46	25	49	24		51	50	90	0.14	−6.0	2	7,649	s.	44	ne.	26	11	8	11	4.9		
Medford	1,425	4					67.0		95	1	83	36	24	51	46					1.67		5		se.				14	9	7			
Portland, Oreg.	153	68	106	29.82	29.97	−.06	67.4	+6.8	90	16	78	45	24	57	33		58	51	61	0.66	−1.2	2	3,626	nw.	24	e.	27	15	8	7	3.9		
Roseburg	510	9	57	29.43	29.98	−.04	66.6	+6.1	95	17	81	39	24	52	44		56	50	64	0.59	−0.4	5	1,696	n.	13	nw.	27	19	8	3	3.0		
Middle Pacific Coast Region.							**62.9**	**−0.6**											**75**	**4.04**	**+3.4**										**5.6**		
Eureka	62	73	89	29.94	30.01	.00	56.6	+1.7	68	28	61	46	24	52	19		54	53	93	1.42	+0.3	6	3,006	n.	21	n.	22	2	5	23	8.2		
Mount Tamalpais	2,375	11	18	27.51	29.97	+.03	60.2	−5.9	80	17	67	46	22	53	24		53	48	69	2.90	+2.3	5	7,387	nw.	35	w.	2	10	10	10	5.4		
Point Reyes Light	490	7	18	29.42	29.94		58.0	+1.9	75	11	62	52	30	54	22					1.96		3	9,813	nw.	49	nw.	22	2	11	17	7.7		
Red Bluff	332	50	56	29.55	29.90	−.03	71.4	−2.5	99	17	83	53	23	60	36		61	53	59	7.46	+6.7	7	2,699	se.	13	se.	14	14	11	5	3.7		
Sacramento	69	106	117	29.85	29.92	+.03	67.4	−1.7	90	17	78	50	23	56	37		60	55	70	3.58	+3.2	6	5,239	s.	22	s.	3	19	6	5	3.4		
San Francisco	155	209	213	29.79	29.96	+.02	62.2	+2.9	80	11	68	54	25	57	20		57	55	82	2.53	+2.2	4	6,111	sw.	29	sw.	17	6	11	13	5.7		
San Jose	141	12	110	29.83	29.98		64.4	−0.3	82	1	74	48	24	55	29					6.33	+6.0	5	3,137	nw.	18	nw.	7	10	12	8	5.0		
South Pacific Coast Region.							**70.3**	**+3.0**											**71**	**0.47**	**+0.3**										**4.3**		
Fresno	327	89	98	29.55	29.90	+.03	72.5	−1.8	98	1	86	51	23	60	37		61	53	57	0.53	+0.3	6	5,166	nw.	35	nw.	12	19	6	5	2.9		
Los Angeles	338	159	191	29.55	29.90	+.02	72.2	+5.7	99	11	81	58	5	64	30		63	59	72	0.55	+0.5	4	3,962	sw.	24	ne.	26	13	8	9	4.7		
San Diego	87	62	70	29.81	29.90	+.01	70.6	+3.7	94	11	76	57	26	65	25		64	62	77	0.08	0.0	3	4,524	nw.	22	s.	13	13	12	5	4.5		
San Luis Obispo	201	32	40	29.73	29.95	+.02	65.8	+4.3	90	10	75	50	9	57	38		58	55	78	0.73	+0.3	6	2,864	nw.	17	n.	11	12	9	9	5.1		
West Indies.																																	
San Juan, P. R.	82	8	54	29.87	29.95	+.01	80.5		91	4	86	71	24	75	16					5.58	−1.2	18	7,179	se.	36	e.	9	10	16	4	4.3		
Panama Canal.																																	
Balboa Heights	118	7	97	29.73	29.85	+.02	80.8	+0.9	91	29	87	72	15	74	17		75	74	90	7.03	−0.7	13	4,050	nw.	27	n.	9	0	21	9	6.9		
Colon	36	30	97	29.82	29.85	+.02	80.0	+0.2	87	19	84	72	10	76	12		77	76	82	15.34	+2.7	20	4,988	w.	26	sw.	6	0	9	21	8.3		
Alaska.																																	
Juneau							52.2		73	7	60	34	21	44	28		48	46	91	12.39		14	2,579	se.	26	ne.	25	8	7	15	6.5		

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during September, at all stations furnished with self-registering gages.*

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive rate began.	Depths of precipitation (in inches) during periods of time indicated.													
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Abilene, Tex.	19			0.24														0.22			
Albany, N. Y.	26			2.18														0.51			
Alpena, Mich.	18			0.36														0.32			
Amarillo, Tex.	5			0.31														0.26			
Anniston, Ala.	3	4:45 p. m.	5:58 p. m.	1.38	4:56 p. m.	5:22 p. m.	0.03	0.10	0.42	0.86	1.23	1.31	1.34								
	19	4:14 p. m.	5:45 p. m.	1.24	4:18 p. m.	4:48 p. m.	0.01	0.21	0.55	0.60	0.82	1.01	1.12								
Asheville, N. C.	5			0.70														0.59			
Atlanta, Ga.	3	11:30 a. m.	12:50 p. m.	1.14	11:40 a. m.	12:10 p. m.	0.05	0.11	0.33	0.72	0.87	0.92	0.97								
Atlantic City, N. J.	8			0.77														0.35			
Augusta, Ga.	7			0.78														0.32			
Baker, Oreg.	29			0.23														0.13			
Baltimore, Md.	18			1.01														0.36			
Bentonville, Ark.	19	1:05 a. m.	1:35 a. m.	0.58	1:12 a. m.	1:23 a. m.	0.01	0.34	0.51	0.56											
	25	8:35 a. m.	10:25 a. m.	1.47	8:38 a. m.	9:05 a. m.	0.03	0.23	0.55	0.75	0.81	0.87	0.92								
Binghamton, N. Y.	26			1.84														0.35			
Birmingham, Ala.	3	6:19 a. m.	7:54 a. m.	1.04	7:05 a. m.	7:28 a. m.	0.03	0.21	0.57	0.68	0.90	1.00									
		1:54 p. m.	6:06 p. m.	2.19	2:15 p. m.	2:40 p. m.	0.01	0.40	1.04	1.53	1.83	1.97									
Bismarck, N. Dak.	10			0.13														0.10			
Block Island, R. I.	13			1.54														0.82			
Boise, Idaho.	22–23			1.31														0.21			
Boston, Mass.	13	D. N. a. m.	8:30 a. m.	2.30	4:44 a. m.	6:10 a. m.	0.56	0.06	0.13	0.17	0.23	0.31	0.37	0.42	0.50	0.56	0.62	0.81	1.15	1.26	
	18	11:05 a. m.	5:58 p. m.	1.42	5:12 p. m.	5:41 p. m.	0.88	0.05	0.17	0.26	0.37	0.44	0.53								
Buffalo, N. Y.	24			0.38														0.18			
Burlington, Vt.	17			0.65														0.27			
Cairo, Ill.	15–16	9:45 p. m.	6:10 p. m.	2.62	6:41 a. m.	7:18 a. m.	0.86	0.12	0.20	0.31	0.39	0.47	0.57	0.62	0.65						
Canton, N. Y.	26			0.51														0.35			
Charles City, Iowa.	14	8:58 a. m.	1:20 p. m.	0.68	10:54 a. m.	11:08 a. m.	0.06	0.17	0.44	0.51											
Charleston, S. C.	20	3:45 p. m.	6:35 p. m.	0.71	4:07 p. m.	4:35 p. m.	0.03	0.06	0.10	0.27	0.41	0.50	0.54								
Charlotte, N. C.	19–20	D. N. p. m.	D. N. a. m.	2.52	11:57 p. m.	12:57 a. m.	0.01	0.28	0.62	0.84	1.06	1.27	1.44	1.57	1.75	1.77	1.80	1.98			
Chattanooga, Tenn.	12			0.23														0.22			
Cheyenne, Wyo.	2			0.79														0.39			
Chicago, Ill.	2			0.33														0.21			
Cincinnati, Ohio.	4			0.58														0.29			
Cleveland, Ohio.	2–3	9:32 p. m.	2:30 a. m.	1.18	12:24 a. m.	12:40 a. m.	0.60	0.09	0.25	0.48	0.53										
					5:02 a. m.	5:52 a. m.	0.93	0.05	0.11	0.23	0.34	0.41	0.53	0.66	0.83	0.99	1.14				
					5:52 a. m.	6:42 a. m.	.....	1.23	1.34	1.47	1.61	1.72	1.86	1.95	2.06	2.21	2.29				
	2	D. N. a. m.	10:22 a. m.	6.61	6:42 a. m.	7:32 a. m.	.....	2.35	2.37	2.50	2.82	3.14	3.31	3.48	3.59	3.67	3.73				
					7:32 a. m.	8:22 a. m.	.....	3.79	3.93	4.04	4.15	4.28	4.45	4.57	4.70	4.81	4.89				
					8:22 a. m.	9:05 a. m.	.....	5.02	5.17	5.29	5.34	5.39	5.41	5.48	5.60	5.64					
Columbia, Mo.	3–4	5:23 p. m.	8:50 a. m.	1.90	1:49 a. m.	2:37 a. m.	0.70	0.06	0.15	0.24	0.31	0.39	0.45	0.53	0.62	0.69					
Columbia, S. C.	7–8	12:30 p. m.	10:15 a. m.	2.46	1:02 p. m.	1:20 p. m.	0.15	0.22	0.34	0.43	0.51										
Columbus, Ohio.	16			1.30														0.39			
Concord, N. H.	17			0.81														0.58			
Concordia, Kans.	24	6:54 p. m.	7:55 p. m.	0.67	6:57 p. m.	7:10 p. m.	0.01	0.29	0.50	0.57											
Corpus Christi, Tex.	19–20	D. N. p. m.	8:45 a. m.	2.83	3:29 a. m.	4:09 a. m.	0.22	0.31	0.48	0.70	0.98	1.33	1.60	1.77	1.86						
Dallas, Tex.	25	9:36 p. m.	11:27 p. m.	1.07	9:45 p. m.	10:05 p. m.	0.01	0.38	0.64	0.90	1.02										
Davenport, Iowa.	2			0.89														0.37			
Dayton, Ohio.	12	D. N. a. m.	D. N. a. m.	1.28	12:51 a. m.	1:40 a. m.	0.06	0.10	0.20	0.27	0.32	0.43	0.52	0.57	0.67	0.74	0.79				
Del Rio, Tex.	5	1:10 p. m.	2:10 p. m.	0.76	1:21 p. m.	1:46 p. m.	0.02	0.13	0.27	0.50	0.62	0.69									
Denver, Colo.	5			1.02														0.23			
Des Moines, Iowa.	10			0.44														0.18			
Detroit, Mich.	4			2.10														0.70			
Devils Lake, N. Dak.	1			0.28														0.18			
Dodge City, Kans.	2–3			1.40														*			
Drexel, Nebr.	30			0.56														0.19			
Dubuque, Iowa.	10			0.85														0.21			
Duluth, Minn.	11			0.49														0.21			
Eastport, Me.	20	D. N. a. m.	10:00 a. m.	1.09	7:09 a. m.	7:23 a. m.	0.08	0.13	0.49	0.76											
Elkins, W. Va.	16–17			0.83														0.37			
Ellendale, N. Dak.	2			0.05														0.05			
El Paso, Tex.	1			0.01														0.01			
Erie, Pa.	21			0.64														0.34			
Escanaba, Mich.	11			1.13														0.26			
Eureka, Cal.	12			0.29														0.18			
Evansville, Ind.	4			1.15														0.29			
Flagstaff, Ariz.	3–4			0.46														*			
Fort Smith, Ark.	4	D. N. a. m.	6:57 a. m.	1.56	3:46 a. m.	4:56 a. m.	0.19	0.13	0.22	0.40	0.49	0.49	0.49	0.50	0.65	0.72	0.79	0.94	1.21		
Fort Wayne, Ind.	4	7:40 a. m.	D. N. p. m.	4.17	3:22 p. m.	4:22 p. m.	2.19	0.06	0.15	0.39	0.55	0.65	0.68	0.71	0.80	0.86	1.02	1.33			
Fort Worth, Tex.	4	6:15 a. m.	4:46 p. m.	1.56	6:21 a. m.	6:40 a. m.	0.01	0.14	0.31	0.43	0.50										
Fresno, Cal.	27			0.11														0.11			
Galveston, Tex.	19–20	9:40 p. m.	8:10 a. m.	1.21	12:26 a. m.	12:47 a. m.	0.23	0.21	0.37	0.45	0.53	0.58									
Grand Haven, Mich.	18			0.43														0.28			
Grand Junction, Colo.	4			0.35														0.31			
Grand Rapids, Mich.	11			1.04														0.20			
Green Bay, Wis.	9			0.47														0.30			
Greenville, S. C.	19			1.09														0.51			
Hannibal, Mo.	1–2	10:50 p. m.	9:25 a. m.	2.70	1:56 a. m.	2:53 a. m.	0.23	0.08	0.22	0.40	0.43	0.47	0.60	0.83	0.97	1.00	1.21	1.38			
Harrisburg, Pa.	18			1.23														0.32			
Hartford, Conn.	26			1.84														0.77			
Hatteras, N. C.	28–29			0.94														*			
Havre, Mont.	1			0.57														0.15			
Helena, Mont.	23			0.33														0.16			
Houghton, Mich.	2			0.70														0.20			
Houston, Tex.	18–19	8:40 p. m.	7:30 a. m.	1.80	11:13 p. m.	11:51 p. m.	0.19	0.10	0.27	0.46	0.74	0.96	1.01	1.05							
Huron, S. Dak.	24			0.14														0.07			
Independence, Cal.	29			0.14														0.12			
Indianapolis, Ind.	11–12	9:25 p. m.	D. N. a. m.	1.50	9:42 p. m.	10:06 p. m.	0.01	0.07	0.13	0.33	0.56	0.64									
Iola, Kans.	3			1.40														0.57			
Jacksonville, Fla.	19	2:05 p. m.	3:18 p. m.	0.90	2:24 p. m.	2:53 p. m.	0.04	0.07	0.13	0.23	0.47	0.57	0.63								
Kalispell, Mont.	1			0.68														0.24			
Kansas City, Mo.	1–2	8:20 p. m.	6:00 a. m.	3.99	10:15 p. m.	10:45 p. m.	0.32	0.08	0.19	0.31	0.67	0.80	0.86								
					2:10 a. m.	3:13 a. m.	2.13	0.25	0.35	0.43	0.57	0.65	0.83	0.93	0.96	1.11	1.27	1.53	1.61		
Keokuk, Iowa.	11			0.44														0.16			
Key West, Fla.	3	10:05 a. m.	12:25 p. m.	2.01	10:27 a. m.	11:15 a. m.	0.01	0.40	0.88	1.06	1.15	1.27	1.40	1.57	1.74	1.85	1.90				
Knoxville, Tenn.	12			0.22														0.22			
La Crosse, Wis.	10			0.62														0.15			
Lander, Wyo.	14			0.42														0.11			
Lansing, Mich.	7			0.25														0.23			
Lewiston, Idaho.	22			0.16														0.05			
Lexington, Ky.	4			0.47														0.31			
Lincoln, Nebr.	1			0.97														0.68			

* Self-register not in use.

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during September, at all stations furnished with self-registering gages*—Continued.

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive rate began.	Depths of precipitation (in inches) during periods of time indicated.													
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Little Rock, Ark	19	6:01 a. m.	11:15 a. m.	2.36	6:13 a. m.	6:56 a. m.	0.05	0.14	0.35	0.78	0.95	1.07	1.22	1.36	1.43	1.48	.....	.....	.....	.....	.....
Los Angeles, Cal	27	.....	.....	0.24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.15	.....	.....	.....
Louisville, Ky	12	.....	.....	0.95	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.49	.....	.....	.....
Ludington, Mich	6	.....	.....	0.43	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.43	.....	.....	.....
Lynchburg, Va	5	.....	.....	0.57	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.37	.....	.....	.....
Macon, Ga	5	11:13 a. m.	12:13 p. m.	0.84	11:22 a. m.	11:42 a. m.	0.05	0.10	0.31	0.58	0.74	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Madison, Wis	10	.....	.....	0.63	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.19	.....	.....	.....
Marquette, Mich	17–18	.....	.....	1.34	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Memphis, Tenn	4	6:20 p. m.	D. N. p. m.	0.80	9:41 p. m.	9:58 p. m.	0.03	0.18	0.40	0.70	0.76	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Meridian, Miss	26	11:05 a. m.	2:15 p. m.	1.38	11:36 a. m.	12:26 p. m.	0.04	0.25	0.64	0.86	0.87	0.90	0.95	1.04	1.11	1.16	1.27	.....	.....	.....	.....
Miami, Fla	12	4:28 p. m.	5:50 p. m.	1.09	4:30 p. m.	5:03 p. m.	0.01	0.19	0.55	0.74	0.79	0.84	0.97	1.03	.....	.....	.....	.....	.....	.....	.....
	14	6:25 p. m.	7:15 p. m.	0.97	6:41 p. m.	7:03 p. m.	0.02	0.14	0.53	0.71	0.89	0.95	.....	.....	.....	.....	.....	.....	.....	.....	.....
	18	11:38 a. m.	2:25 p. m.	0.92	12:18 p. m.	1:00 p. m.	0.06	0.12	0.22	0.23	0.38	0.40	0.49	0.62	0.77	0.83	.....	.....	.....	.....	.....
	23	5:10 p. m.	D. N. p. m.	1.30	6:52 p. m.	7:23 p. m.	0.13	0.12	0.21	0.36	0.45	0.51	0.57	.....	.....	.....	.....	.....	.....	.....	.....
	24	4:05 p. m.	D. N. p. m.	2.82	6:14 p. m.	6:51 p. m.	0.20	0.31	0.67	0.83	1.07	1.40	1.59	1.69	1.75	.....	.....	.....	.....	.....	.....
					7:45 p. m.	8:04 p. m.	2.11	0.08	0.22	0.41	0.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Milwaukee, Wis	11	.....	.....	0.79	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.23	.....	.....	.....
Minneapolis, Minn	10	.....	.....	0.87	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.18	.....	.....	.....
Mobile, Ala	20	.....	.....	1.05	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.60	.....	.....	.....
Modena, Utah	4	.....	.....	0.51	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.20	.....	.....	.....
Montgomery, Ala	5	.....	.....	1.02	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.41	.....	.....	.....
Moorhead, Minn	14	.....	.....	0.06	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.06	.....	.....	.....
Mount Tamalpais, Cal	12	.....	.....	1.27	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.20	.....	.....	.....
Nantucket, Mass	20	.....	.....	0.87	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.47	.....	.....	.....
Nashville, Tenn	4–5	.....	.....	1.88	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.54	.....	.....	.....
New Haven, Conn	12–13	8:02 p. m.	D. N. a. m.	2.05	1:25 a. m.	3:10 a. m.	0.25	0.07	0.15	0.23	0.31	0.39	0.44	0.50	0.59	0.68	0.74	0.84	1.29	1.64	1.79
New Orleans, La	6	D. N. a. m.	6:05 a. m.	2.38	2:53 a. m.	4:05 a. m.	0.36	0.10	0.15	0.25	0.35	0.57	0.80	1.00	1.11	1.25	1.40	1.75	1.92	.....	.....
New York, N. Y	18	.....	.....	1.35	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.36	.....	.....	.....
Norfolk, Va	8	.....	.....	0.79	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.59	.....	.....	.....
Northfield, Vt	6	.....	.....	0.57	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.21	.....	.....	.....
North Head, Wash	29	.....	.....	T.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	T.	.....	.....	.....
North Platte, Nebr	3	.....	.....	0.16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.12	.....	.....	.....
Oklahoma, Okla	3–4	.....	.....	1.93	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Omaha, Nebr	30	.....	.....	0.51	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.16	.....	.....	.....
Oswego, N. Y	13	.....	.....	0.77	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.26	.....	.....	.....
Palestine, Tex	26	1:20 a. m.	3:15 a. m.	0.64	2:15 a. m.	2:45 a. m.	0.06	0.11	0.21	0.29	0.39	0.45	0.50	.....	.....	.....	.....	.....	.....	.....	.....
Parkersburg, W. Va	3	.....	.....	0.81	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.24	.....	.....	.....
Pensacola, Fla	26	.....	.....	1.33	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.44	.....	.....	.....
Peoria, Ill	11	.....	.....	0.53	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.17	.....	.....	.....
Philadelphia, Pa	17–18	10:15 p. m.	11:45 a. m.	2.68	11:51 p. m.	12:26 a. m.	0.25	0.11	0.19	0.22	0.24	0.36	0.48	0.59	.....	.....	.....	.....	.....	.....	.....
Phoenix, Ariz	2	.....	.....	0.32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.16	.....	.....	.....
Pierre, S. Dak	24	.....	.....	0.34	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.07	.....	.....	.....
Pittsburgh, Pa	12	.....	.....	0.44	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.27	.....	.....	.....
Pocatello, Idaho	9	.....	.....	0.07	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.04	.....	.....	.....
Point Reyes Light, Cal	12	.....	.....	1.01	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.22	.....	.....	.....
Port Angeles, Wash	29	.....	.....	0.10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.08	.....	.....	.....
Port Huron, Mich	4	.....	.....	1.70	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.42	.....	.....	.....
Portland, Me	17	.....	.....	0.89	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.70	.....	.....	.....
Portland, Oreg	13	.....	.....	0.63	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.15	.....	.....	.....
Providence, R. I	12–13	8:30 p. m.	7:30 a. m.	2.01	5:13 a. m.	4:13 a. m.	0.28	0.16	0.41	0.51	0.55	0.59	0.65	0.70	0.73	0.80	1.03	1.29	.....	.....	.....
	18	11:45 a. m.	5:25 p. m.	1.27	4:25 p. m.	4:53 p. m.	0.20	0.19	0.25	0.32	0.47	0.75	0.99	.....	.....	.....	.....	.....	.....	.....	.....
	26	10:00 a. m.	4:10 p. m.	1.95	12:40 p. m.	1:30 p. m.	0.10	0.10	0.20	0.31	0.36	0.43	0.47	0.52	0.60	0.66	0.75	.....	.....	.....	.....
					1:30 p. m.	2:02 p. m.	.....	0.86	1.02	1.14	1.23	1.27	1.35	1.43	.....	.....	.....	.....	.....	.....	.....
Pueblo, Colo	5	.....	.....	0.92	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.26	.....	.....	.....
Raleigh, N. C	18	7:51 p. m.	D. N. p. m.	1.00	8:06 p. m.	8:28 p. m.	0.04	0.18	0.51	0.72	0.80	0.83	.....	.....	.....	.....	.....	.....	.....	.....	.....
Rapid City, S. Dak	2	.....	.....	0.47	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.28	.....	.....	.....
Reading, Pa	18	.....	.....	0.99	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.37	.....	.....	.....
Red Bluff, Cal	13–14	1:33 p. m.	D. N. a. m.	6.00	9:46 p. m.	10:36 p. m.	0.50	0.06	0.10	0.15	0.20	0.29	0.40	0.47	0.52	0.57	0.63	.....	.....	.....	.....
					10:36 p. m.	11:26 p. m.	.....	0.69	0.73	0.80	0.88	0.92	1.05	1.20	1.27	1.36	1.47	.....	.....	.....	.....
					11:26 p. m.	12:16 a. m.	.....	1.56	1.62	1.64	1.71	1.78	1.92	2.05	2.24	2.47	2.66	.....	.....	.....	.....
					12:16 a. m.	1:06 a. m.	.....	2.78	2.92	3.03	3.19	3.33	3.56	3.65	3.87	4.13	4.38	.....	.....	.....	.....
					1:06 a. m.	1:46 a. m.	.....	4.54	4.65	4.85	4.99	5.07	5.17	5.36	5.43	.....	.....	.....	.....	.....	.....
Reno, Nev	13	.....	.....	0.97	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.25	.....	.....	.....
Richmond, Va	6	.....	.....	0.96	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.48	.....	.....	.....
Rochester, N. Y	12	.....	.....	0.44	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.34	.....	.....	.....
Roseburg, Oreg	13	.....	.....	0.28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.10	.....	.....	.....
Roswell, N. Mex	18	6:53 p. m.	8:27 p. m.	0.76	6:59 p. m.	7:32 p. m.	0.01	0.17	0.35	0.45	0.55	0.65	0.71	0.74	.....	.....	.....	.....	.....	.....	.....
Sacramento, Cal	12	.....	.....	3.13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.38	.....	.....	.....
Saginaw, Mich	18	.....	.....	0.23	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.23	.....	.....	.....
St. Joseph, Mo	1–2	6:35 p. m.	6:30 a. m.	3.44	2:55 a. m.	4:12 a. m.	0.92	0.17	0.30	0.33	0.43	0.51	0.64	0.78	0.93	1.18	1.28	1.64	2.06	.....	.....
St. Louis, Mo	4	.....	.....	1.93	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.54	.....	.....	.....
St. Paul, Minn	10	.....	.....	0.94	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.25	.....	.....	.....
Salt Lake City, Utah	23	.....	.....	0.74	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.26	.....	.....	.....
San Antonio, Tex	19	.....	.....	1.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.50	.....	.....	.....
San Diego, Cal	14	.....	.....	0.06	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.04	.....	.....	.....
Sand Key, Fla	22	4:20 a. m.	6:35 a. m.	1.07	5:43 a. m.	6:12 a. m.	0.02	0.22	0.45	0.59	0.79	0.93	1.02	.....	.....	.....	.....	.....	.....	.....	.....
Sandusky, Ohio	4	.....	.....	1.35	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.38	.....	.....	.....
Sandy Hook, N. J	18	.....	.....	1.18	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.54	.....	.....	.....
San Francisco, Cal	12–13	.....	.....	1.54	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
San Jose, Cal	11–12	.....	.....	4.47	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.57	.....	.....	.....
San Luis Obispo, Cal	13	.....	.....	0.45	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.09	.....	.....	.....
Santa Fe, N. Mex	3	.....	.....	0.46	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.24	.....	.....	.....
Sault Ste. Marie, Mich	18	.....	.....	0.74	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.23	.....	.....	.....
Savannah, Ga	7	12:35 p. m.	10:00 p. m.	1.58	12:41 p. m.	1:07 p. m.	0.01	0.10	0.21	0.35	0.60	0.87	0.89	.....	.....	.....	.....	.....	.....	.....	.....
	15	12:05 a. m.	D. N. a. m.	0.74	12:26 a. m.	12:48 a. m.	0.07	0.08	0.32	0.46	0.56	0.60	.....	.....	.....	.....	.....	.....	.....	.....	.....
Scranton, Pa	25	.....	.....	0.57	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.40	.....	.....	.....
Seattle, Wash	29	.....	.....	0.08	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.05	.....	.....	.....
Sheridan, Wyo	29	.....	.....	0.73	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.17	.....	.....	.....
Shreveport, La	26	.....	.....	0.19	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.08	.....	.....	.....
Sioux City, Iowa	9	.....	.....	0.30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.04	.....	.....	.....
Spokane, Wash	30	.....	.....	0.18	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.10	.....	.....	.....
Springfield, Ill	4	D. N. a. m.	12:26 p. m.	2.18	4:55 a. m.	5:55 a. m.	0.92	0.05	0.11	0.19	0.25	0.31	0.41	0.50	0.55	0.61	0.70	0.96	.....	.....	.....
Springfield, Mo	16	D. N. a. m.	5:36 a. m.	1.22	2:13 a. m.	3:11 a. m.	0.02	0.07	0.25	0.38	0.54	0.64	0.65	0.67	0.75	0.79	0.90	1.04	.....	.....	.....
	19	D. N. a. m.	8:02 a. m.	1.02	12:47 a. m.	1:12 a. m.	0.05	0.09	0.17	0.29	0.38	0.55	.....	.....	.....	.....	.....	.....	.....	.....	.....
Syracuse, N. Y	20	.....	.....	0.79	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.34	.....	.....	.....
Tacoma, Wash	29	.....	.....	0.45	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.18	.....	.....	.....
Tampa, Fla	27–28	1:25 p. m.	D. N. a. m.	2.06	8:41 p. m.	9:09 p. m.	0.78	0.13	0.30	0.53	0.67	0.76	0.83	.....	.....	.....	.....	.....	.....	.....	.....
	29	5:00 a. m.	5:55 a. m.	1.52	5:04 a. m.	5:36 a. m.	0.01	0.36	0.65	0.97	1.22	1.24	1.39	1.49	.....	.....	.....	.....	.....	.....	.....
Tatoosh Island, Wash	29	.....	.....	0.10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.08	.....	.....	.....
Taylor, Tex	19	.....	.....	0.46	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.38	.....	.....	.....
Terre Haute, Ind	4	.....	.....	2.15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.39	.....	.....	.....

* Self-register not in use. † Record partly estimated. ‡ No precipitation occurred during month.

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during September, at all stations furnished with self-registering gages*—Continued.

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive rate began.	Depths of precipitation (in inches) during periods of time indicated.														
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Thomasville, Ga.	20	2:05 p. m.	3:08 p. m.	0.84	2:34 p. m.	2:55 p. m.	0.03	0.28	0.42	0.62	0.79	0.81	....	....	....	....	....	....	....	....	....
Toledo, Ohio	4–5	9:27 a. m.	D. N. a. m.	5.96	4:24 p. m.	5:14 p. m.	.....	0.09	0.21	0.26	0.30	0.34	0.36	0.45	0.53	0.70	0.80	.....	.....	.....	.....
					5:14 p. m.	6:04 p. m.	.....	0.88	0.98	1.06	1.12	1.21	1.26	1.31	1.47	1.55	1.62	.....	.....	.....	.....
					6:04 p. m.	7:11 p. m.	.....	1.71	1.91	2.05	2.16	2.24	2.34	2.46	2.54	2.56	2.59	.....	.....	.....	.....
					6:57 p. m.	10:45 p. m.	1.41	2.67	2.78	2.85	2.89	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Tonopah, Nev.	22	....	....	0.29	....	....	....	....	....	....	....	....	....	....	....	....	....	0.29	....	....	....
Topeka, Kans.	1	6:57 p. m.	D. N. p. m.	2.72	9:12 p. m.	10:37 p. m.	0.05	0.45	0.58	0.67	0.77	0.84	0.95	1.15	1.34	1.52	1.58	1.72	2.12	2.23	.....
Trenton, N. J.	18	....	....	1.85	....	....	....	....	....	....	....	....	....	....	....	....	....	0.58	....	....	....
Valentine, Nebr.	24	....	....	0.69	....	....	....	....	....	....	....	....	....	....	....	....	....	0.26	....	....	....
Vicksburg, Miss.	18	....	....	0.56	....	....	....	....	....	....	....	....	....	....	....	....	....	0.25	....	....	....
Walla Walla, Wash.	9	....	....	0.19	....	....	....	....	....	....	....	....	....	....	....	....	....	0.11	....	....	....
Washington, D. C.	18	....	....	1.01	....	....	....	....	....	....	....	....	....	....	....	....	....	0.45	....	....	....
Wausau, Wis.	10	....	....	0.35	....	....	....	....	....	....	....	....	....	....	....	....	....	0.12	....	....	....
Wichita, Kans.	3	....	....	1.26	....	....	....	....	....	....	....	....	....	....	....	....	....	0.45	....	....	....
Williston, N. Dak.	1	....	....	0.28	....	....	....	....	....	....	....	....	....	....	....	....	....	0.13	....	....	....
Wilmington, N. C.	17	....	....	0.21	....	....	....	....	....	....	....	....	....	....	....	....	....	0.21	....	....	....
Winnemucca, Nev.	22	....	....	0.39	....	....	....	....	....	....	....	....	....	....	....	....	....	0.20	....	....	....
Wytheville, Va.	5	....	....	1.19	....	....	....	....	....	....	....	....	....	....	....	....	....	0.35	....	....	....
Yankton, S. Dak.	9	....	....	0.72	....	....	....	....	....	....	....	....	....	....	....	....	....	0.17	....	....	....
Yellowstone Park, Wyo.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

* Self-register not in use. † Record partly estimated. ‡ No precipitation occurred during month.

TABLE III.—*Data furnished by the Canadian Meteorological Service, September, 1918.*

Stations.	Altitude above M. S. L.* Jan. 1, 1916.	Pressure.			Temperature.						Precipitation.		
		Station reduced to mean of 24 hours.	Sea-level reduced to mean of 24 hours.	Departure from normal.	Mean max.+ mean min.÷2.	Departure from normal.	Mean maximum.	Mean minimum.	Highest.	Lowest.	Total.	Departure from normal.	Total snowfall.
	Feet.	*Inches.*	*Inches.*	*Inches.*	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*	*Inches.*	*Inches.*	*Inches.*
St. Johns, N. F.	125	29.95	30.09	+0.12	55.8	+1.8	64.2	47.4	78	35	2.74	−0.97	.....
Sydney, C. B. I.	48	30.02	30.06	+ .05	60.1	+3.6	68.0	52.3	77	41	4.53	+1.25	.....
Halifax, N. S.	88	29.94	30.04	.00	58.4	+0.8	65.6	51.3	78	37	5.56	+1.85	.....
Yarmouth, N. S.	65	29.94	30.01	− .04	57.5	+1.4	64.9	50.2	79	35	8.77	+5.32	.....
Charlottetown, P. E. I.	38	29.97	30.01	.00	60.1	+2.8	65.4	54.9	78	41	5.90	+2.50	.....
Chatham, N. B.	28	30.00	30.02	+ .02	55.8	+0.4	64.1	47.6	78	32	6.94	+4.23	.....
Father Point, Que.	20	29.95	29.97	− .01	48.5	−1.9	55.1	41.9	67	30	5.86	+2.73	.....
Quebec, Que.	296	29.68	30.00	− .01	52.1	−3.0	58.8	45.4	78	30	9.43	+5.76	.....
Montreal, Que.	187	29.79	30.00	− .04	54.5	−3.9	61.1	48.0	78	34	7.82	+4.52	.....
Stonecliffe, Ont.	489	29.37	29.98	− .05	51.5	−4.2	60.0	43.0	76	30	4.66	+1.38	.....
Ottawa, Ont.	236	29.73	29.99	− .05	54.3	−3.1	63.4	45.3	80	30	6.30	+3.61	.....
Kingston, Ont.	285	29.70	30.01	− .03	56.0	−4.0	62.9	49.1	76	36	4.39	+1.59	.....
Toronto, Ont.	379	29.61	30.01	− .05	56.5	−2.5	65.6	47.3	81	39	4.64	+1.39	T.
White River, Ont.	1,244	28.67	30.00	+ .02	42.3	−8.0	53.0	31.6	68	20	4.43	+1.66	.....
Port Stanley, Ont.	592	29.40	30.04	− .02	55.5	−4.0	64.5	46.6	77	36	4.57	+1.84	.....
Southampton, Ont.	656	29.29	.....	.....	53.0	−4.5	60.2	45.9	76	35	2.87	−0.07	T.
Parry Sound, Ont.	688	29.31	30.01	− .02	53.1	−2.9	62.2	44.0	75	29	4.00	+0.33	.....
Port Arthur, Ont.	644	29.34	30.05	+ .07	47.7	−4.5	58.1	37.4	71	25	2.42	−1.06	.....
Winnipeg, Man.	760	29.28	30.12	+ .18	48.4	−4.1	60.6	36.2	76	26	0.62	−1.41	.....
Minnedosa, Man.	1,690	28.30	30.12	+ .18	48.8	−1.7	62.6	35.1	81	24	1.15	−0.21	.....
Qu'Appelle, Sask.	2,115	27.85	30.11	+ .19	50.1	−1.0	64.8	35.5	84	19	0.77	−0.56	.....
Medicine Hat, Alberta	2,144	27.77	30.04	+ .12	57.4	+2.4	73.8	41.0	87	28	0.26	−0.92	.....
Swift Current, Sask.	2,392	27.51	30.08	+ .16	53.1	0.0	69.0	37.2	87	22	0.70	−0.52	.....
Calgary, Alberta	3,428	26.57	30.08	+ .16	56.9	+7.1	72.4	41.5	84	30	0.97	−0.39	.....
Banff, Alberta	4,521	25.53	30.08	+ .15	51.8	+6.0	67.7	35.9	78	28	1.40	−0.27	.....
Edmonton, Alberta	2,150	27.79	30.07	+ .17	52.4	+3.1	66.1	38.8	82	27	1.44	+0.11	.....
Prince Albert, Sask.	1,450	28.57	30.13	+ .23	50.8	+2.4	64.8	36.8	81	24	0.40	−0.88	.....
Battleford, Sask.	1,592	28.37	30.12	+ .22	52.1	+0.3	66.5	37.7	84	20	0.24	−1.01	.....
Kamloops, B. C.	1,262	28.81	30.09	+ .12	62.8	+5.4	78.6	46.9	85	41	0.38	−0.47	.....
Victoria, B. C.	230	29.77	30.02	+ .01	59.9	+5.1	68.6	51.2	83	44	0.10	−2.06	.....
Barkerville, B. C.	4,180	25.86	30.18	+ .20	49.6	+2.9	63.3	36.0	69	3)	0.17	−2.74	.....
Hamilton, Bermuda	151	29.90	30.06	− .01	77.6	+0.2	82.2	73.1	85	68	7.56	+1.05	.....

* *See* Explanation of Tables in this REVIEW for January, 1918, p. 48.

Chart I. Hydrographs of Several Principal Rivers, September, 1918.

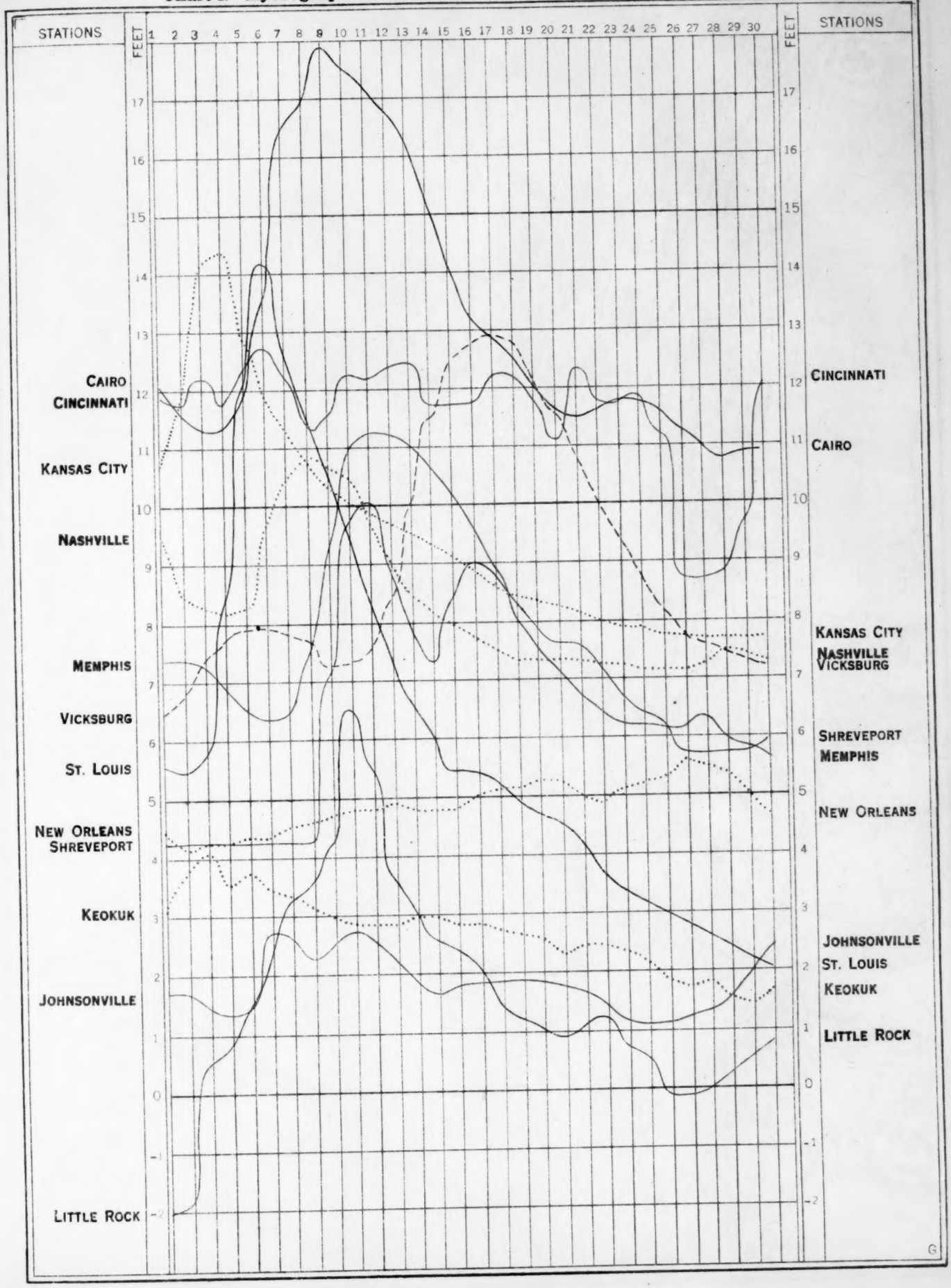

Chart II. Tracks of Centers of High Areas, September, 1918.

(Plotted by Charles A. Donnel.)

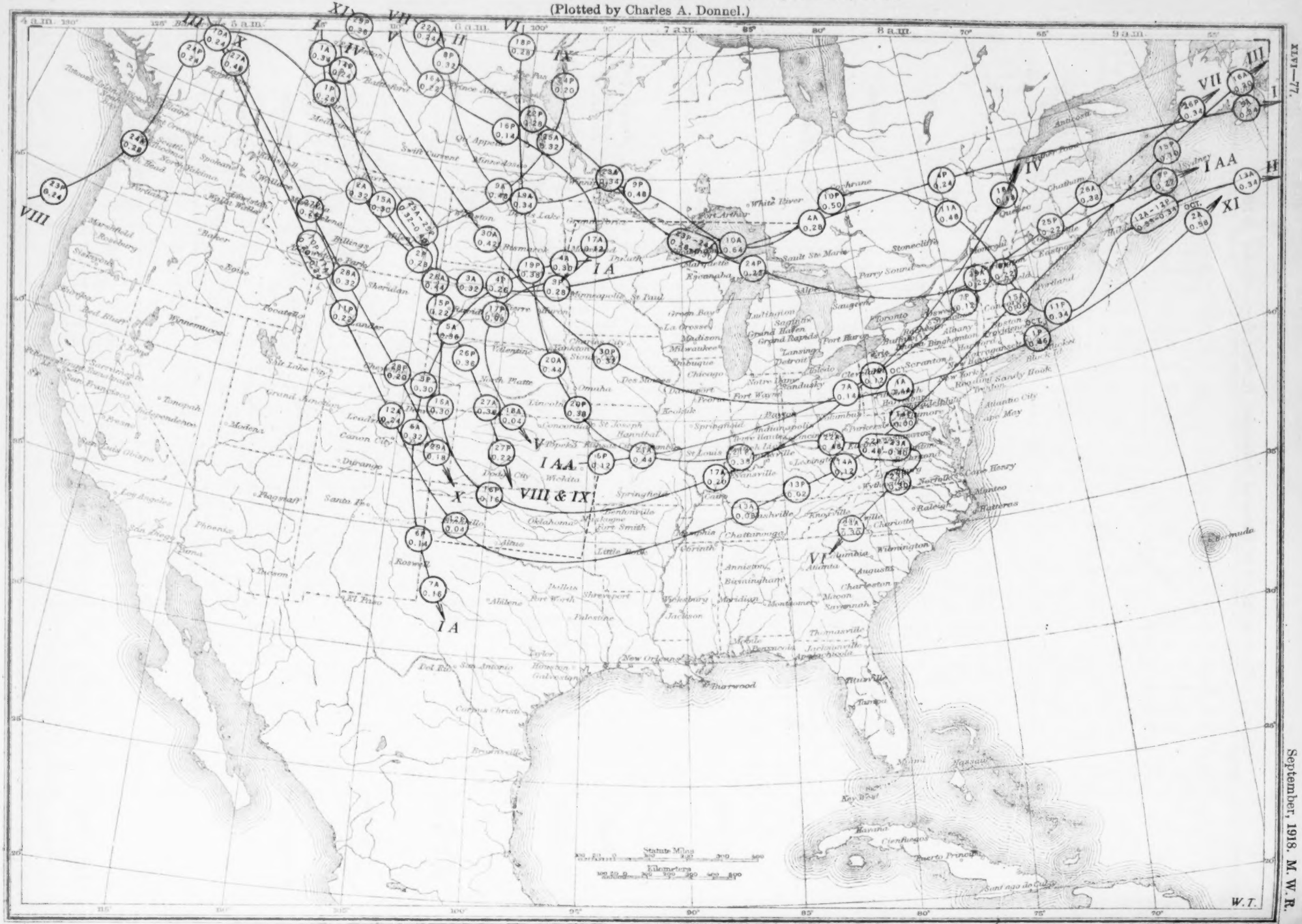

Chart III. Tracks of Centers of Low Areas, September, 1918.

Chart III. Tracks of Centers of Low Areas, September, 1918.

(Plotted by Charles A. Donnel.)

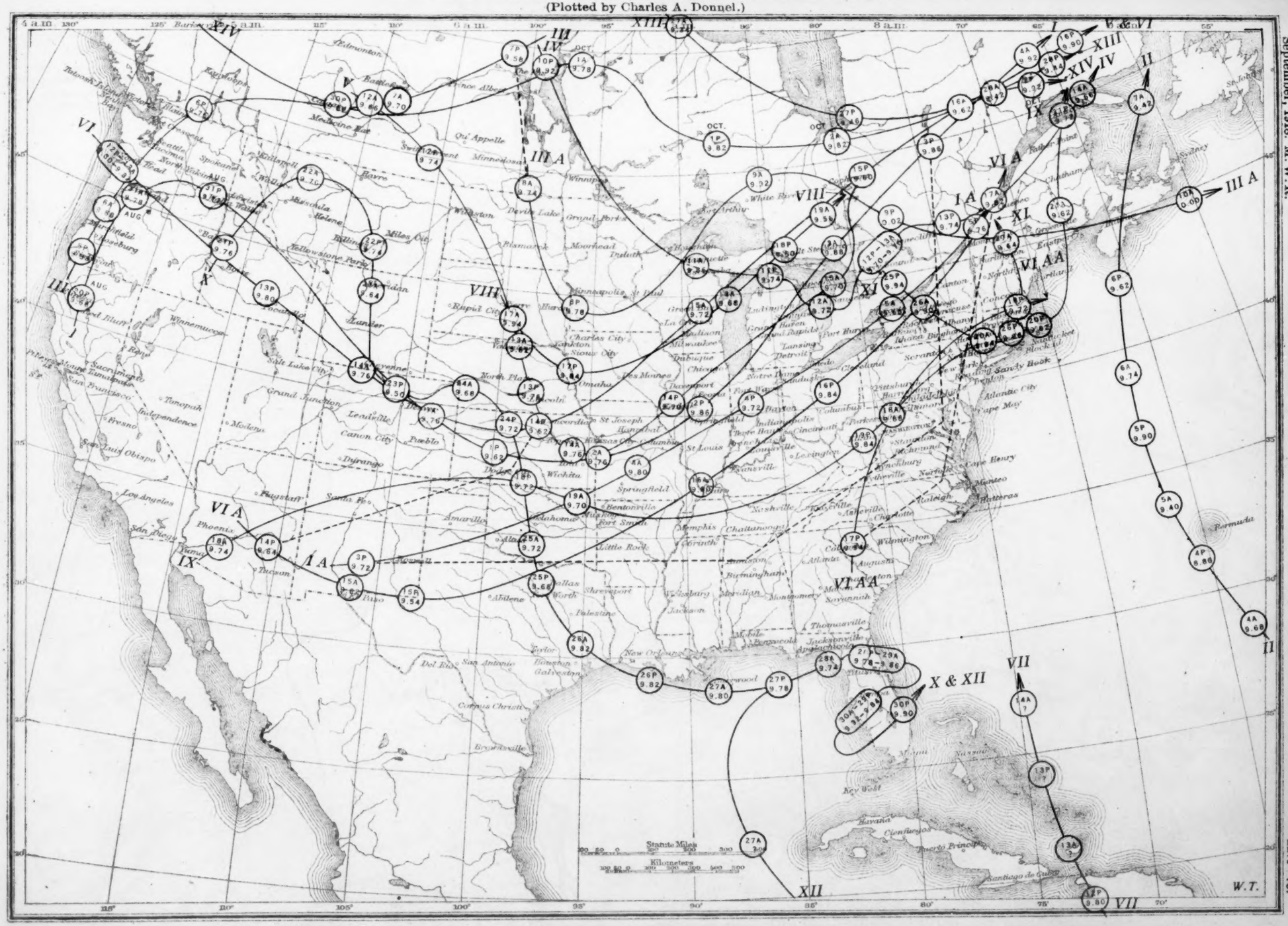

Chart IV. Departure (°F.) of the Mean Temperature from the Normal, September, 1918.

Chart V. Total Precipitation, Inches, September, 1918.

Chart V. Total Precipitation, Inches, September, 1918.

Chart VI. Percentage of Clear Sky between Sunrise and Sunset, September, 1918.

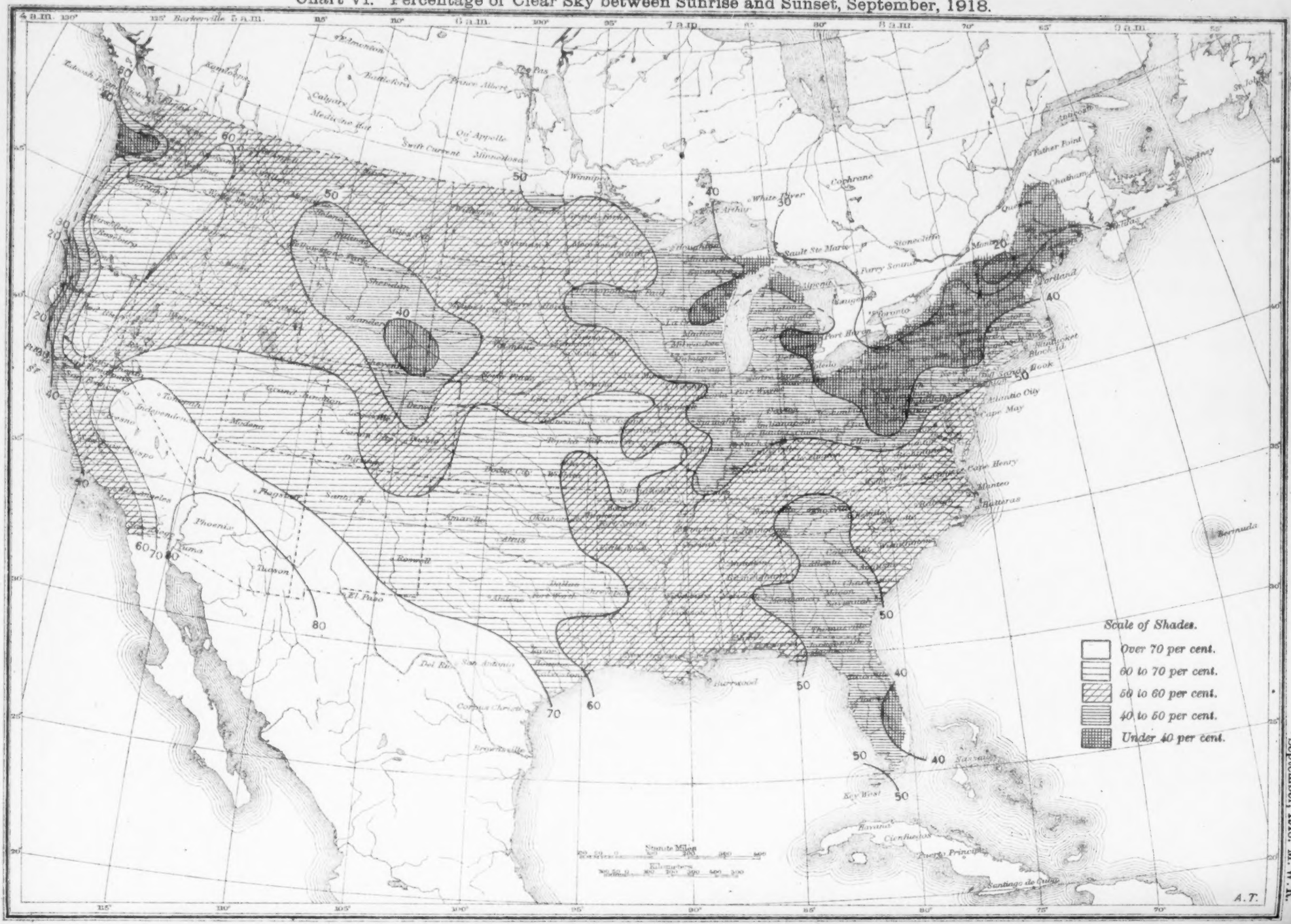

Chart VII. Isobars and Isotherms at Sealevel; Prevailing Winds, September, 1918.

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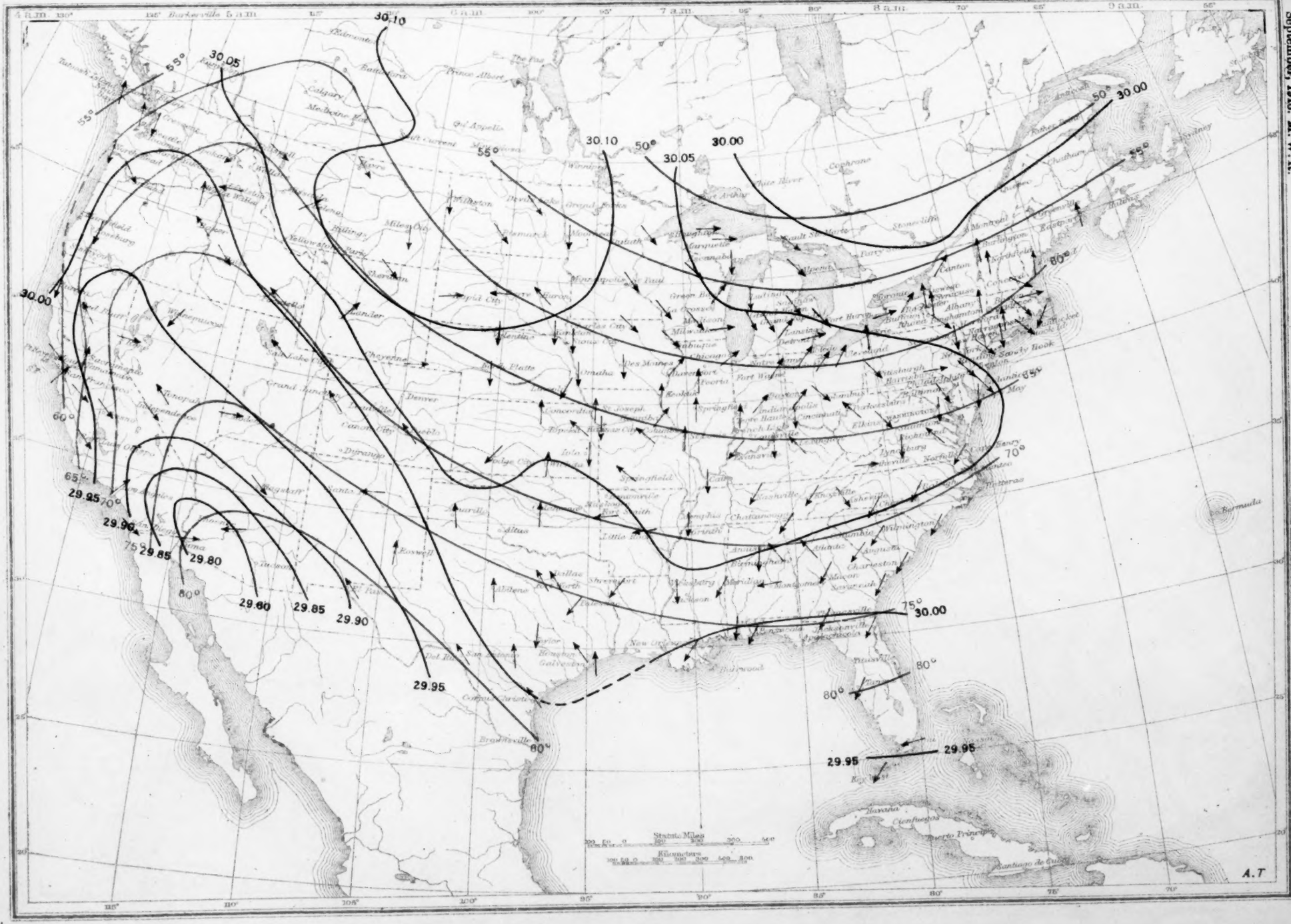

September, 1918. M. W. R.

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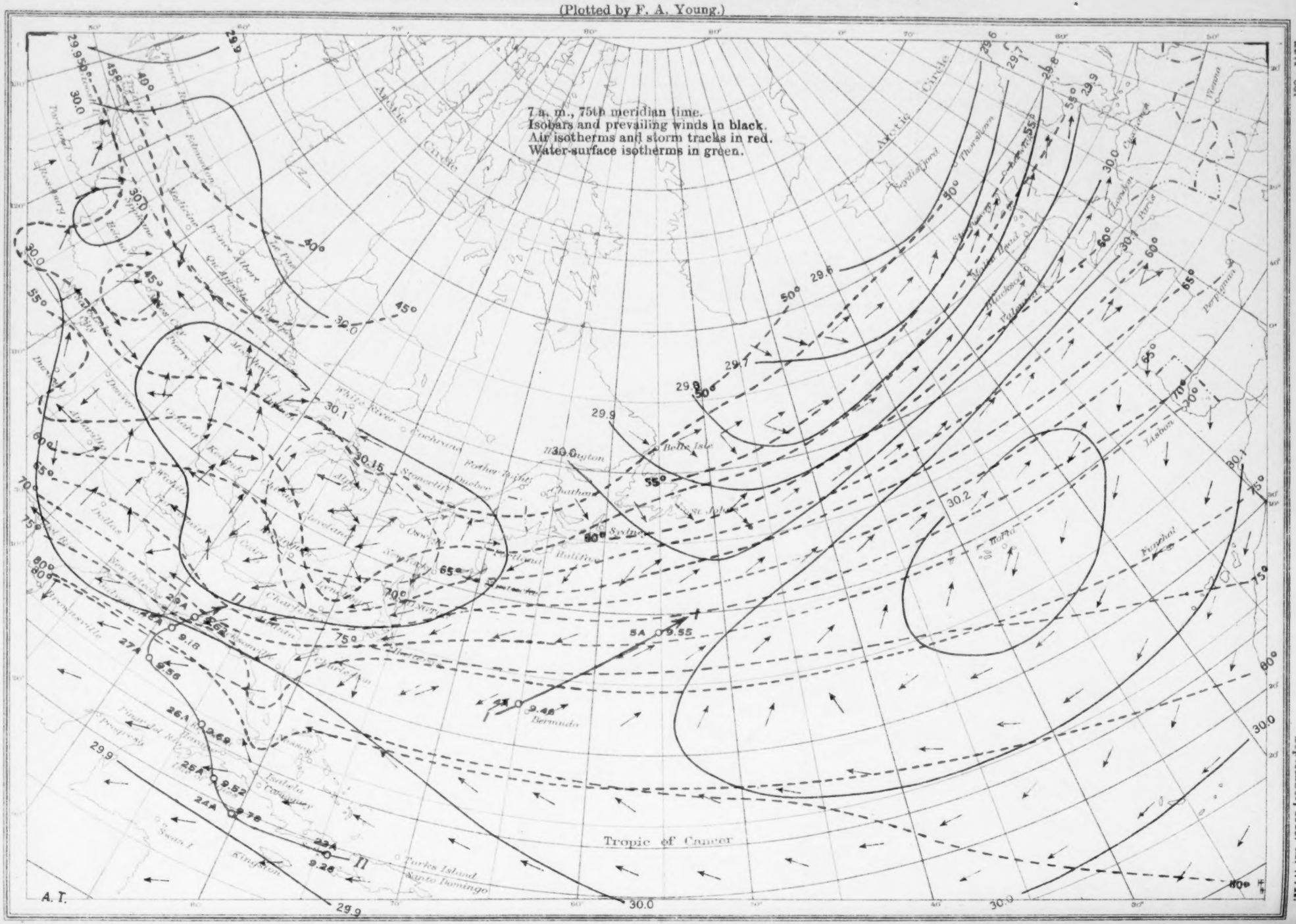
Chart IX. Means of Meteorological Data for North Atlantic Ocean, September, 1917.

(Plotted by F. A. Young.)